Auto-instructional aids: A comparison of covert with overt self-correcting feedback in the acquisition of association responses by normal infant school children.

by

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This thesis contains no material which has been accepted for the award of any other higher degree or graduate diploma in any university and, to the best of the candidate's knowledge and belief, the thesis contains no material previously published or written by another person, except when due reference is made in the text of the thesis.

B.J. Burton .....

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ABSTRACT

The study compared two types of self-correcting feedback commonly found in so-called auto-instructional aids intended to facilitate the acquisition of association responses in young children. To study this effect two manually operated aids, differing only on the covertness or overtness of a physical linkage clue (as in a jigsaw puzzle), were designed and used in the teaching of eight novel stimulus pairs. The sample consisted of 24 seven year-old grade one subjects (12M, 12F) randomly selected from a middle-class socio-economic infant school. These were randomly allocated to the four cells of the study's 2x2 factorial design, independent variables being type of feedback and sex. Dependent variables were the number of errors occurring during learning and the number of criterion responses (6 consecutively correct) to any one stimulus pair during immediate retention testing or delayed retention testing occurring 24 hours later. An investigatory probe was also conducted into the time factor during learning. It was hypothesized that more errors would occur during learning under the covert physical linkage (CPL) condition than under the overt physical linkage (OPL). It was also hypothesized that the CPL correcting device would produce more effective learning than the OPL device when measured during both immediate and delayed retention testing. No significant sex difference in learning for both the CPL and OPL conditions was hypothesized. A 2x2 analysis of variance was applied to the results of each independent variable. These analyses showed that, significantly more errors occurred under the CPL condition than under the OPL condition (p = 0.0000****); the CPL condition produced significantly more learning than the OPL condition when measured during immediate retention testing (p = 0.0195*) as well as during

delayed retention testing (p = 0.0060**); a significant interaction effect was evident when measuring learning during immediate retention testing (p = 0.0382*). This latter effect was a result of learning by male CPL subjects being significantly higher than that of CPL females (p = 0.0149*). Probes conducted on the number of errors during, and time of, each learning trial revealed that female subjects, while following a similar learning pattern to that of males, took longer and made more errors initially during the experiment than males. Possible explanations for this are discussed. It was concluded that auto-instructional aids containing CPL feedback facilitate the acquisition of association responses in both male and female infant school children by forcing attention to the critical stimuli. The assumption that OPL feedback facilitates such learning was not supported by this study. The irrelevant stimulus, the physical linkage clue, was seen as a major distractor to the learning task as almost no learning occurred under this condition for both males and females. Some implications were discussed.

CHAPTER 1

INTRODUCTION

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Special education, as defined by Smith and Neisworth (1975), is "concerned with the arrangement of educational variables leading to the prevention, reduction, or elimination of those conditions that produce significant defects in the academic, communicative, locomotor, or adjustive functioning of children"(p.13). Of special education's two major concerns, namely prevention and remediation, this study focuses on the preventative aspect. The study grew from an interest in preventing conditions which may produce initial academic learning problems for normal infant school children.

It is evident from the literature that educators recognize, at least theoretically, the importance of individualizing instruction in preventing learning problems. It is also evident that the potential to achieve individualization has been greatly increased by the rapid advance of technology during the past two decades. However, it was as early as 1907 that Maria Montessori made a systematic attempt at implementing a psychological theory of learning by developing self-instructional and self-corrective teaching materials which allowed the teacher to assume the role of guide and supervisor within a classroom (Montessori, 1965).

In 1926 an instructional machine was developed by Sidney Pressey which reduced the demand on a teacher's personal attention and time during the learning process. The design of the aid, known as the Pressey Drum Tutor, was based on the stimulus-response theory of the psychologist, Edward L. Thorndike (Fine, 1963). Since that

time, and particularly during recent years, a vast range of teaching materials has developed. Many designs are built, as was Pressey's pioneer aid, on the foundation work of Thorndike and the more recent scientific investigations of B.F. Skinner (1953, 1958). Educational technology surveys (Cleary, Mayes, & Packham, 1976; Fine, 1963) indicate that many devices, both in software (e.g. programmed learning texts) and hardware (e.g. computerized learning programmes), designed to individualize the rate and content of the user's learning are currently available. Most of these devices are auto-instructional in the sense that they are self-teaching and self-correcting. Many contain built-in feedback systems which indicate to the learner at the time of responding, knowledge of correctness and/or incorrectness.

However, the sophistication of such devices is costly thus limiting their usage. Furthermore, the complexity of the majority places a restriction on their appropriateness for some students, particularly young children and exceptional children having physical and/or intellectual handicaps. As Cleary et al (1976) state; "relatively little work by educational technologists has been directed specifically at the pre-school or special education groups" (p.25).

Representative of the few devices suitable for younger and less able children are the Touch Tutor (see Figure 1), a rather sophisticated electronic device used in conjunction with a slide projector, and the Stimulus-Response Programmer (Behavioural Controls) (see Figure 2) described by Cleary et al (1976). A further example is the Learning Association Module (see Figure 3), a non-electronic manually operated device, designed by Jackson (1976).

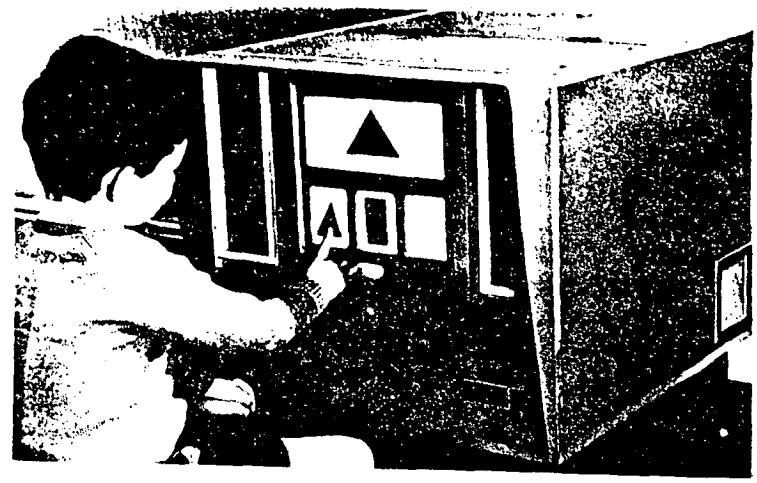


FIGURE 1 Touch Tutor
(p.45, Cleary et al, 1976)

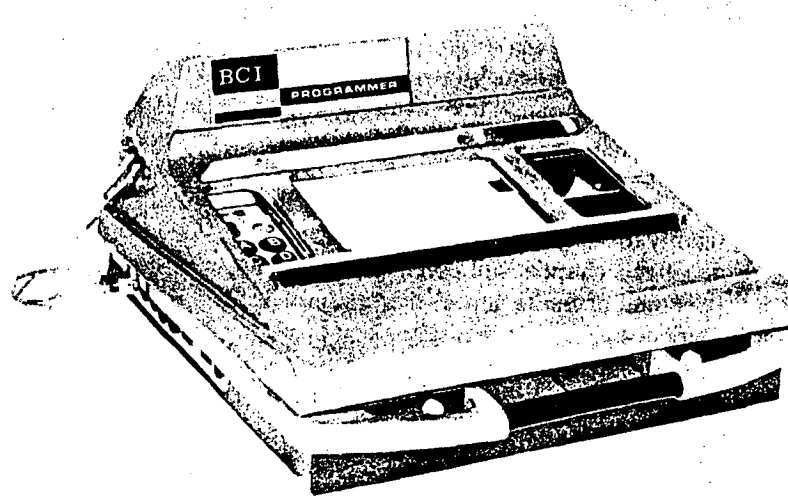


FIGURE 2 Stimulus Response Programmer
(Behavioural Controls)
(p.64, Cleary et al, 1976)

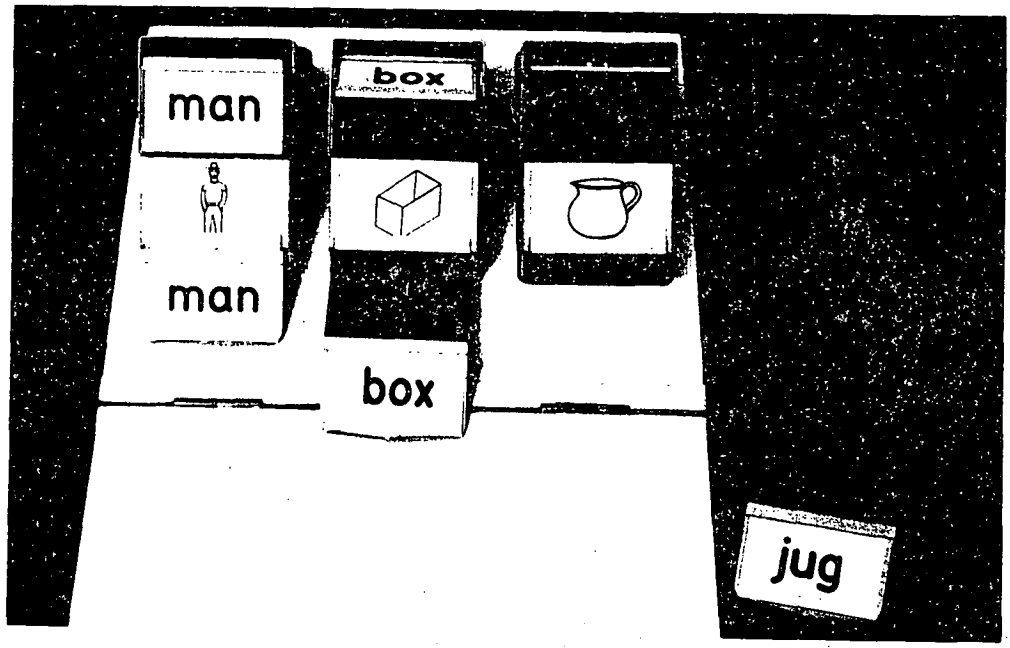


FIGURE 3 The Jackson Learning Association Modules

The aid consists of a display panel, a number of response keys and a feedback window all displaying associative stimuli. The child is required to select a key and position it directly below its matching display panel. When a correct response is made the feedback window immediately opens. An incorrect response results in failure to open the feedback window.

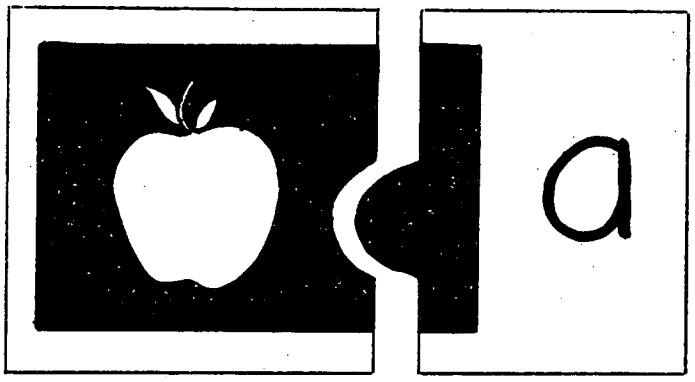
Cleary et al (1976) emphasize the sound learning theory underlying the design of these aids when they state that all employ "the principle of requiring the child to perform an active discriminative response to displayed information followed by immediate knowledge of results" (p.51).

At the commencement of this study, a survey of current advertising material from major educational suppliers for Australian schools was conducted. It revealed a vast number of less sophisticated aids designed specifically for young children. Many

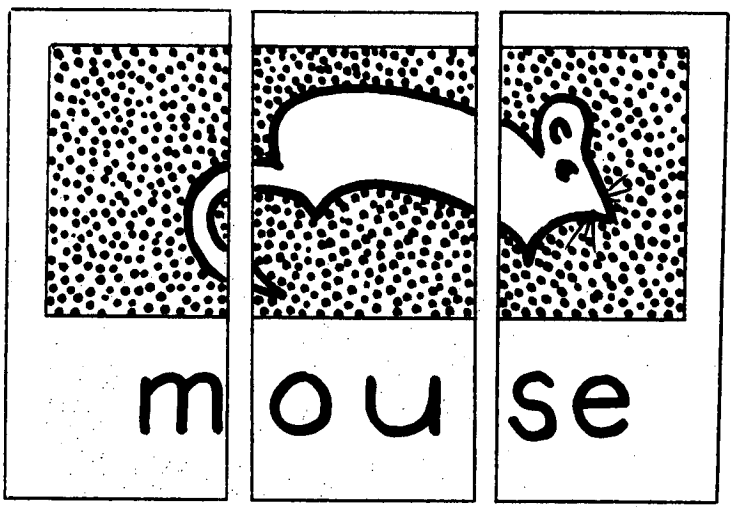
were designed for individual use and were "self-correcting". It was observed that the "self-correcting" device or built-in feedback system on the majority of aids designed to facilitate association learning (as in learning to read), provided immediate feedback. That is, the child received knowledge of results at the time of responding. He did not have to complete a set of matchings before receiving feedback.

Some of the more sophisticated aids provided such feedback via electric probes and electric or battery connected circuit lights. However, the feedback on a vast number of less costly but more widely used aids consisted of a clue (or prompt) or combination of clues which appeared to be irrelevant to the learning objective of the matching task involved. The clue took several forms, namely; colour, continuous lines, pictures, physical linkage as in a jigsaw, and a combination of such clues. Several examples of such overt clues are illustrated in Figure 4. It appeared that a child could successfully complete a matching task, as in associating pictures with names or numbers with sets of objects, without any purposeful attention to the stimuli to be learned.

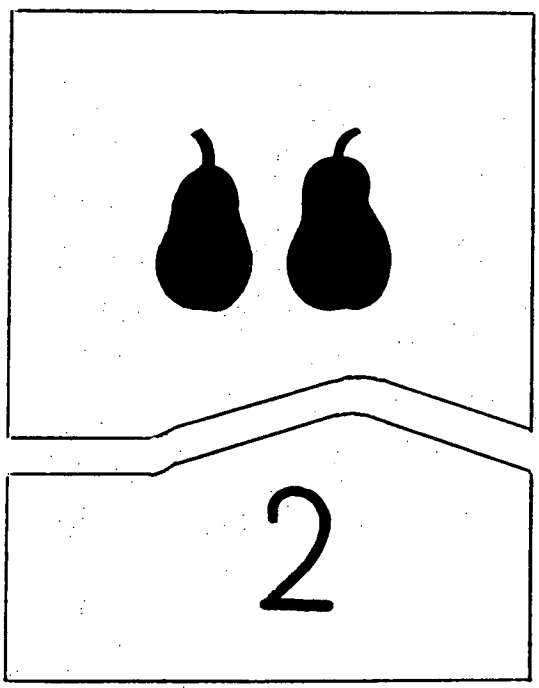
The feedback design of such aids was in direct contrast to that of the more sophisticated aids described previously. For example, close observation of the Jackson Learning Association Modules in use by beginning readers revealed that the device contained no distracting clue to draw the attention of the learner away from the critical stimuli to be learned. In fact, the design of the device made it difficult for the learner to avoid attending to the relevant stimuli. It appeared that such a device was auto-instructional in a higher sense than many other so-called auto-instructional or self-



colour/physical linkage clues



picture/colour clues



physical linkage clues

FIGURE 4 Examples of overt feedback clues

correcting aids. It not only contained a built-in immediate feedback system but ensured that the learner attended to the relevant stimuli prior to, during, as well as after making a discriminative response.

From the survey conducted and the described observations the following research question grew.

1.1 Research question

In the acquisition of association responses by normal infant school children (as in learning to read) "auto-instructional" aids signalling immediate knowledge of correctness or incorrectness to the learner are frequently utilized by teachers. The self-correcting nature of many such aids consists of an overt clue, such as physical shape linkage in a puzzle, irrelevant to the learning task. These aids operate on the assumption that overt physical associations indicating correctness and incorrectness facilitate appropriate learning of relevant stimuli. This study seeks to examine the utility of a number of so-called teaching aids by investigating the feedback process in such aids. In particular it sets out to test the theory that automatic feedback in the form of covert physical linkage will produce more effective learning of association responses than automatic feedback in the form of overt physical linkage.

CHAPTER 2

A SURVEY OF RELEVANT LITERATURE

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2.1 The role of feedback in auto-instructional devices

One of the most significant aspects of all learning is that of feedback or knowledge of results. In describing key aspects of learning theory DeCecco and Crawford (1974) describe feedback as the information available to the learner which makes possible a comparison of his actual response or performance with the correct or standard performance. Since auto-instructional aids given to young children purport to facilitate learning it is essential to examine the role feedback plays in such devices.

Miller (1953) distinguishes between two types of feedback which he designates learning feedback and action feedback. By the term learning feedback he refers to knowledge of results coming after the completion of a response. Such feedback therefore has no control over the response it is measuring but is used by the learner to determine subsequent responses. The built-in feedback system on the Jackson Learning Association Module, previously described, illustrates this type of feedback in aids suitable for young children. Miller's term action feedback, however, refers to any feedback which arrives and is used while a response is being made. Those aids containing initial clues as to which stimuli should be associated in a matching task illustrate a form of this feedback type. Of the two types Skinnerian theory places learning feedback as being crucial to learning and this theory has been supported by the evidence of success in children's association learning occurring

in conjunction with teaching aids such as the Learning Association Modules (Jackson, 1972, 1972a, 1977; Smith, 1975).

A search of the literature revealed that very few studies have examined the role of feedback in auto-instructional aids designed for young children. It appeared that investigations by Jackson (1972, 1974,1977a), during the process of examining word object association behaviour in trainable retarded children and by Smith (1975) working with normal preschool children constitute the most relevant research evidence on feedback for this study. These investigations compared the learning of association responses by trainable mentally handicapped children and normal preschoolers under different feedback conditions using the Learning Association Module as the methodological procedure. These studies will now be presented.

Jackson (1972) explored a technique aimed at inducing reading behaviour in trainable mentally handicapped children aged eight to thirteen years. In constructing apparatus for the investigation Jackson developed what was to be the forerunner of the present Learning Association Module (Figure 3). Of importance to this discussion is the major difference between the two devices as they relate to feedback conditions. As can be seen from Figure 3 the Learning Association Module in its present form permits the simultaneous presentation of three stimuli when a correct response has been made. Exactly what constitutes these three stimuli depends on what has been positioned on the response key, display panel and feedback window. For instance, a picture and two presentations of its word referent could be presented, or, two identical pictures plus one word referent. Note that at the time of a correct response there is always a display of the matching stimulus pair even in the

event of the feedback window displaying a blank card. On the other hand, the former association teaching device used during Jackson's study differed in that, at the time of making a correct response, the response key 'disappeared' and only the display panel and feedback window displayed stimuli. It is seen that with the former aid it would be quite possible for the final display not to contain both the picture and word stimuli of an associated pair. This difference needs to be kept in mind when considering the results of Jackson's study.

The study conducted by Jackson involved four experiments. The aim of Experiment 1 was to see whether in fact moderately mentally handicapped children would be able to acquire association responses using this device. The learning task involved the matching of small object replicas of familiar environmental things with their trigram word referent. As the response key was slotted in at the left-hand side of the display panel in this device the three sections of the aid contained Word (W)-Object(O)-Word(W) in a left to right fashion. The final display however was O-W as the response key 'disappeared' in this aid. Jackson concluded from this first experiment that his subjects were able to learn with such an aid and then carried out a further three experiments to see which feedback information, if any, produced superior learning.

Experiment 2 compared an O-W-O learning condition with an O-W-W condition. Jackson found that the object feedback acted as a distractor. For example, he observed children touching the objects on the feedback windows. It was clear that visual focus was not on the object of discrimination which was the unfamiliar graphic word stimulus. Although there was no statistically significant

difference in learning between the W-O and the W-W feedback displays in this experiment, more subjects were successful in the W-W condition. Jackson concluded that this condition increased the value of the discriminative stimulus for the subject.

In the third experiment three conditions were compared; those of Experiment 2 (O-W-O and O-W-W) plus an O-W-Neutral. In the latter condition the feedback display consisted of a white blank card. From the results Jackson concluded that each of the feedback variables (object, word, neutral card) acted as reinforcement. Learning occurred under all conditions with word feedback producing more efficient learning. In discussing these results Jackson (1972) states:

> "An examination of this phenomena permits certain speculations about the manner in which associative links are formed. This seems to suggest that there are certain important factors in terms of the timing in respect to the formation of an associative link. Since there was no visible feedback in front of the subject at the moment of feedback linking the object and the 'to be learned sign', it is argued that, in terms of temporal order the actual association must have begun to take place when the physical objective act of association was being performed by the subject. It would seem as though the association hypothesis of the subject was entered into short term memory to await confirmation of its correctness by a reinforcement signal" (p.233).

Experiment 4 compared three feedback conditions in which the unknown stimulus, the word, was displayed on the response key (W-O-W; W-O-O; W-O-Neutral). Results indicated no significant evidence in favour of any one condition although they suggest that object feedback may have been the least effective. It was obvious from this experiment, as it was from Experiment 3, that a contiguous visual presentation of the object replica and word referent at the time of feedback was not essential to the visual association learning process. Jackson (1972) in attempting to explain this states:

> "... when the subject scans the stimulus he is about to discriminate or learn, he files this in short term memory then upon the appropriate signal of correctness the subject must make the association by an act of association of the stored memory with the signal 'correct'. Presumably if it is incorrect he exits the initial image from short term memory. After a series of correct signals the visual configuration is presumably transferred to long term memory" (p.259).

Jackson's conclusion is that "the act of association learning occurs when the subject makes his initial response to the stimulus" (p.259).

Smith's study (1975) focused on the finding of Jackson's study that word feedback (designated task specific feedback by both Jackson and Smith) appeared to produce more effective learning than either object, or neutral feedback. Results of a small study by Smith (1974) with only 12 normal preschoolers had suggested that word feedback was more effective than picture feedback but there was no significant difference. The teaching device used in Smith's study (1975) was the present form of the Learning Association Module and as mentioned previously, it was possible for the display at the moment of feedback to consist of a simultaneous presentation of three stimuli. The response key did not 'disappear' as in Jackson's earlier device. Smith compared two feedback conditions: W-Picture (P)-W and W-P-P with both high and low discriminable trigrams. The subjects of the study were 24 normal preschoolers, 12 male and 12 female. Results indicated that while word feedback produced more learning of both high and low discriminable words than did picture feedback, only one measure of learning reached a significant statistical difference. Smith considers that particular measure was the most rigorous test administered. It was a recognition test of low discriminable words containing no picture clues which might act as mnemonic aids. Each word was presented in isolation so there

was no visual evidence by which comparisons between trigrams could be made. Smith concluded from his study, as Jackson had similarly, that word feedback enhances the significance of the word for the learner. It encourages task specific attention. No sex differences in learning were found in Smith's earlier study (1974). Unfortunately his later study (1975), although having sex type as an independent variable, appeared not to report any results relating to it. At this stage discussion will proceed to the second aspect of the literature survey; the relevance of sex differences in responding to auto-instructional devices.

2.2 The relevance of sex differences in responding to auto-instructional devices

From the existing research and evidence available it is not possible to conclude whether learning with auto-instructional devices is more effective for one of the sexes than the other. Whilst Jackson's experiments (1972) and Smith's (1975) have clearly indicated that both male and female mentally handicapped children and normal preschoolers have acquired association responses with such devices quite effectively, neither study indicated whether manually operated teaching apparatus and concentration on visual stimuli presentation effected learning by one sex more than the other. It appears to be solely in Smith's earlier study (1974) that evidence relating to the sex factor is found. As mentioned previously no significant sex difference in learning was found with normal preschoolers when using the Learning Association Module. This dearth of experimental evidence directly relating to sex differences

or similarities in responding to auto-instructional aids may be a result of the inconclusiveness of a vast amount of research investigating sex differences in young children.

Several assumptions frequently made by educators are that manipulative materials favour male learning, females are superior in verbal learning, and whilst males have a stronger visual modality than auditory, females have a stronger auditory modality. One might tentatively conclude from these assumptions that males would be advantaged when instruction involves manually operated auto-instructional aids and a highly visual type of presentation. On the other hand one of the assumptions implies that females may be advantaged when the learning task involves verbal skills. In an association learning task (as in matching pictures and words) with a manipulative auto-instructional device both young males and females may be advantaged or disadvantaged but by different aspects of the task. One might therefore hypothesize that learning would be similar for both sexes. This is purely a subjective and tentative hypothesis.

The aspects considered relevant for examination in this discussion will be limited to the following features; visual and auditory modality preferences, achievement orientation, anxiety, toy and activity preferences of young children, and the verbal superiority of females.

Visual and auditory modality preferences

It is important to consider these aspects as the presentation of the learning experience with the auto-instructional devices designed for this study was a highly visual experience.

When reviewing the evidence for a sex difference in sense modality preference or responsiveness it is seen that most research has investigated the modality of vision. Maccoby and Jacklin's extensive review (1975) of studies in habituation to visual stimuli during the first few days of life shows no sex difference. During later infancy the results tend slightly in the direction of boys habituating more quickly than girls but as Maccoby and Jacklin indicate: "whether this signifies a lower level of interest in visual cues or a greater ability to process them quickly can only be determined by examining the findings of studies that use other measures" (p.27).

Watson (1969) used the infant's rate of conditioning to either auditory or visual reinforcement as a measure of modality preference. His study with 10-week old babies showed conditional fixation for females with auditory reinforcement (or auditory plus visual), but not with visual alone; whereas males conditioned with visual reinforcement. From their review Maccoby and Jacklin consider this study of Watson's has been the evidence most frequently cited to support different sex modality preferences.

Rosner (1973) identified individual differences amongst infant school children in the use of information contained in visual versus auditory stimulus patterns. His results showed that "visual" children do better in arithmetic; the "auditory" children, in reading. Unfortunately he did not report whether or not modality sex differences were found. In citing Rosner's study Maccoby and Jacklin consider that although research shows sex differences in reading and arithmetic achievement to be minimal during infant school "it remains an intriguing possibility however, that modality

preferences during the early school years might feed into the development of different subject-matter skills at a later time. At present it has not been demonstrated that either sex is more "visual" or more "auditory" than the other" (p.35).

Achievement orientation

How do the sexes compare in achievement orientation? This question is relevant to this discussion in that learning with auto-instructional devices is a highly individualized and socially isolated learning experience. Auto-instructional aids having built-in non-social feedback devices release the teacher from personal attention and feedback to the learner's responses. This results in a decrease or absence of social reinforcement in the form of verbal comment or physical contact by the teacher or experimenter.

Garai and Scheinfeld (1968) state: "From early childhood on, males appear to have greater achievement needs directed toward successful task accomplishment, while females exhibit greater affiliative or social needs directed toward successful relations with the people in their environment" (p.270). This is in contrast to the conclusion of Maccoby and Jacklin (1975) who consider there is no conclusive evidence that girls are more interested in social stimulation than boys. Research comparing social reinforcement in the form of verbal experimenter feedback with non-social feedback (Allen, Spear, & Lucke, 1971; Spence, 1972) shows females to be no more affected than males by lack of social reinforcement.

Anxiety

As this study involved young infant school children coping

with an experimental situation which contained unfamiliar teaching apparatus, stimuli to be learned and personnel, it could be hypothesized that anxiety may have hindered learning in some degree. Tobias (1979) suggests that anxiety may effect learning at three main points during instruction. Firstly, it may interfere in the internalization of external stimuli. Wine (1971) also considers that the attention of anxious students is divided between task demands and concern with task-irrelevant preoccupations. Tobias (1979) states: "This type of interference is likely to be cumulative since input that has not been internally represented cannot, of course, be effectively processed" (p.575). Anxiety however, may also interfere during the processing of stimuli as well as during the retrieval of information.

Studies involving the use of general anxiety scales indicate that females have fairly consistently demonstrated greater general anxiety than males. It was noted that the majority of anxiety studies have used subjects older than infant school children. Studies using measures of test anxiety (Douglas & Rice, 1979) have produced similar results. The trend toward apparent greater anxiety in females is interesting when compared with the early work by Jersild and Holmes (1935), cited by Maccoby and Jacklin (1975), on children's fears. The results of this study involving children from over 130 families indicated that, although there was no significant sex difference in the number of subjects displaying fear to any stimulus situation, the intensity of fear response was higher for females.

One might assume that the curiosity and exploration behaviour of young children might be affected by anxiety so in view of the

manipulative activity with unfamiliar equipment and the novel stimuli which were used in the present study this aspect has been briefly examined. It has been researched quite extensively with inconsistent results. Some studies (Baumrind & Black, 1967; Daehler, 1970) indicate a clear trend for males, ranging from 3 to 6 years of age, to demonstrate more curiosity and exploration than their female peers. Other studies (Yando, Zigler & Gates, 1971) have found no such difference.

Toy and activity preferences

A review of the research relating to the toy and activity preferences of young children indicates that this is one of the few areas where quite consistently the sexes differ. Early studies by Farrell (1957) and Honzik (1951) showed that male children showed a distinctly greater preference for play with blocks than females. The more recent studies of Pulaski (1970) and Ward (1968), while not investigating block play, indicate that young males show a decided preference for sex-appropriate toys whilst young females displayed no such preference for typically female stereotyped toys.

Verbal superiority of females

In summarizing the review relating to verbal ability of the sexes Maccoby and Jacklin (1975) conclude that females demonstrate greater ability than males particularly at high school level and beyond. During preschool to adolescence however, the verbal abilities of the sexes are considered by them to be similar. Sherman (1978) considers that the female infant's precocity in verbal communication "is important to the bent twig hypothesis since it supports the possibility that more girls than boys might

establish verbal communication as a preferred mode of interacting with the environment" (p.43). Sherman hypothesizes that this "bent" is increased by the educational system with its verbal emphasis and by stereotyped sex roles that do not encourage the development of visual-spatial abilities in females.

2.3 The role of memory in association learning

Because the relationship between an association such as a word and its meaning or a set of objects and its number is arbitrary, memorization of the association is necessary. This study, in comparing the learning that occurs under certain feedback conditions as seen in auto-instructional devices supposedly designed to facilitate association learning, is therefore directly concerned with memory. In examining theory relating to memory this discussion will focus on the built-in feedback devices of the auto-instructional aids investigated in this study to determine whether or not their designs have sound theoretical bases.

Loftus and Loftus (1976) discuss the theory for a model of memory advanced by several psychologists (Atkinson & Shiffrin, 1968; Glanzer, 1972). The model is known as a two-store system referring to its two major information stores, short-term and long-term store, and will now be briefly described.

Information first enters the sensory store of the memory system via a sense organ. This store is able to hold a large amount of information; essentially all the information impinging on a sense organ. However, unless this information is transferred within one or two seconds to the next store, short-term store, the information

decays quickly.

Short-term store has, in comparison to sensory store, a limited capacity for information (approximately 7 or 8 bits in an adult) according to Miller (1956) and Pollack (1953). This information is lost within 15 seconds unless it is placed into a section of short-term store called a rehearsal buffer. Via rehearsal the information may be maintained indefinitely. The theory underlying this model of memory (Loftus & Loftus, 1976) assumes "that people have the ability to enter whichever information they wish into the rehearsal buffer, allowing other information to decay away from short-term store. The choice of which information is to be entered and which is to be lost is presumably made in such a way that the person can carry out whatever task he is trying to do" (pp.8,9).

While information resides in short-term store it can be transferred into the long-term store. The longer information resides in short-term, the more of it can be transferred to long-term storage which has unlimited capacity and where it will remain, more or less, permanently available.

This review will now more closely examine some processes of the two-store memory model; firstly, the process of transferring information from the preliminary sensory store to the first major store, short-term store. The process of transferring information from sensory store to short-term store is termed 'pattern recognition' because the process consists of recognizing some meaningful representation in the raw physical information (sensory patterns) entering the sensory store (Lindsay & Norman, 1972; Neissner, 1967).

(It is noted that the raw sensory information is probably recoded into an acoustic form (Conrad, 1964; Wickelgren, 1965) and is supplemented by information already in long-term storage.)

As described previously, this model of memory assumes that sensory store has an information capacity much greater than that of short-term store. Loftus and Loftus (1976) consider therefore, that one chooses which information is to be transferred and which left to decay from sensory store. They state: "In deciding which information to transfer, you are essentially deciding to what you are going to attend" (p.31).

Fontana and Evans (1980) indicate that although the importance of short-term memory for success in reading (Guthrie & Goldberg, 1972; Lunzer, Dolan, & Wilkinson, 1976) and in mathematics (Lunzer, Dolan, & Wilkinson, 1976) has been emphasized by investigators, there exists no conclusive findings "on the effect that mode of stimulus presentation has upon optimum short-term memory performance" (p.229). If all stimuli entering the short-term store are recoded acoustically as the two-store memory model assumes, auditory stimulus presentations may be superior to visual stimulus presentations for the reason Fontana and Evans (1980) suggest; "they require no modality transfer before storage" (p.229). A study by Fontana and Evans (1980) compared the effect of aural and visual stimuli presentation to 99 normal primary school children ranging from ages seven to eleven. The short-term memory tests administered to all subjects showed that the auditory stimulus presentation produced consistently superior results for both sexes and each age group.

Reference will now be made to the research question of the

present study as it relates to the memory model process under review. It is obvious that the amount and kind of feedback available to the learner in the auto-instructional devices considered, differ considerably. The device having CPL feedback contains two pieces of graphic information (the stimuli to be associated). In contrast, the device having OPL feedback contains two pieces of graphic information plus two overt physical linkage clues. Consistent with the model of memory, all this visual information enters the iconic sensory store of the learner. In the case of OPL feedback the learner has an obvious choice as to which information he will attend, the stimuli to be learned or the physical linkage clue. With CPL feedback the learner has no such choice to make. Attention to the task relevant stimuli is virtually strengthened and perhaps ensured. Theory indicates that it is only possible for a portion of sensory-store information to be transferred. In view of this the phenomenon of attention is seen as crucial in the learning process.

The Stroop effect demonstrates the availability of meaningful but irrelevant information. In Stroop's study (1935) subjects were required to identify a series of colours and name them. However, the series of colours was not presented as two-dimensional shapes or blobs but as words which were the names of other colours. The actual words were irrelevant to the task but Stroop found they interfered considerably in the identification of the physical colour attribute of each word.

Underwood (1976) considers the Stroop effect a curious phenomenon in comparison with the results of many investigations into the extraction of information from visual and auditory presentations (Darwin, Turvey, & Crowder, 1972; Morton, Crowder, & Prussin, 1971;

Sperling, 1960). In such studies it is common for selection of information to be based on physical cues, not semantic. However, to emphasize the role of attention Underwood (1976) states:

> "Attention may serve not only to discriminate finely between stimuli and to elaborate the associations between stimuli, but also to prevent the response availability of other stimuli which would interfere with the performance of the primary task" (pp.247,248).

The second process examined more closely in this review will be that of information entry into long-term store. The model theorizes that rehearsal keeps information in short-term store for as long as rehearsal continues and acts as a mechanism to transfer information from short-term to long-term. (This is not meant to imply, however, that rehearsal always leads to transfer.) Evidence for the latter transferral function of rehearsal is provided in Hellyer's study (1962). However Loftus and Lofuts (1976) consider it

> "naive to think that rehearsal is the only means by which information is transferred to long-term store ..... We know that we do a good deal besides rehearsing. We elaborate on the information we are trying to remember, we form images; we use little mnemonic tricks; and we try to organize and integrate new information into the existing body of information that we already have stored" (pp.60,61).

This discussion is considered relevant in view of the design of the present study involving a delayed retention test. It was planned to question subjects successful in acquiring association responses as to their strategies for remembering at the conclusion of the experiment.

Craik and Lockhart (1972) theorized that two major types of rehearsal exist and an experiment conducted by Craik and Watkins (1973) provides strong supportive evidence for this theory. In defining the first of Craik and Lockhart's two rehearsal types,

maintenance rehearsal, Loftus and Loftus (1976) state that it "involves taking some kind of information and creating only a low-level, transient, acoustic code for it. This code may then be maintained indefinitely - but no information is transferred to long-term store" (p.61). The second type, elaborative rehearsal, "involves taking information and creating elaborate codes - for example, associative codes, imaginal codes, organizational codes - that are stable and later retrievable from long-term store" (p.61).

2.4 A summary of the literature

Although feedback is a significant aspect of learning few studies have examined its role in auto-instructional aids designed to facilitate the acquisition of association responses in young children. There is evidence indicating that a device having a covert feedback signalling system facilitates association learning. In this situation, feedback is provided immediately at the time of the learner's responding, but not before. There appear to be no studies investigating the association learning that may or may not occur with a device containing an overt feedback signalling system. This latter system not only signals feedback when a response has been made in a matching task, but may serve as a prompt or clue (prior to response) as to which stimuli are to be associated. There is also some evidence which suggests that feedback conditions emphasizing the relevant task rather than detracting from it, produce more effective learning.

The relevance of sex differences in response to association learning with auto-instructional devices was examined in view of

common assumptions that mechanical and visual presentations favour male learning and that females are superior in verbal learning. Findings relating to visual/auditory modality preferences, achievement orientation, anxiety, toy and activity preferences, and the verbal superiority were presented. It was seen that inconclusiveness characterizes the research relating to modality preferences, achievement orientation and (for primary school aged children) the verbal precocity of females. Investigations into the anxiety factor generally indicate that females are more negatively affected by anxiety than males. Furthermore, research into the toy and activity preferences of young children shows quite consistent differences. Male children have a greater preference for play with blocks and are more likely to choose sex-appropriate toys and activities than females.

In view of the fact that much association learning consists of arbitrary relations, memory is regarded as having an important role. The two-store model of memory was discussed as it relates to the design of the auto-instructional aids being investigated. It was seen that an overt feedback signalling device presents the learner with a greater amount of visual stimuli than does a covert feedback signalling device. Furthermore, it presents the learner with a choice as to which stimuli he will attend; the task relevant or task irrelevant. The crucial aspect of attention, an essential condition if sensory information is to enter the short-term memory store, was seen as being assisted by an auto-instructional aid having a covert feedback signalling device.

A computer based search of the literature revealed that no previous research had compared the covertness and overtness of self-

correcting devices characteristic of so-called auto-instructional aids purportedly designed to facilitate the acquisition of association responses in young children.

2.5 Research hypothesis

I That feedback in the form of covert physical linkage (CPL) (characteristic of a number of auto-instructional devices) will produce more effective learning of association responses by normal infant school children than feedback in the form of overt physical linkage (OPL) (also characteristic of numerous instructional aids).

(The criterion for effective learning of association responses will be said to have occurred when a subject makes 6 consecutively correct association responses to any one stimulus pair during the 6 testing trials of

(i) immediate retention testing, or

(ii) delayed retention testing.)

II That there will be no significant sex difference in the effective learning of association responses for both the CPL and the OPL feedback conditions.

III That more errors will occur during the learning process with CPL conditions than with OPL conditions.

CHAPTER 3

METHOD

CHAPTER 3

METHOD

3.1 Subjects and sample

An individual sampling unit was used; the sample consisting of 24 Ss (12M and 12F). The source of the sample was a large state infant school in a middle class socio-economic metropolitan area.*

3.1.1 Characteristics of subjects

Each subject had to meet the following criteria:

(i) to be at least of average intelligence;

(ii) to be within the C.A. range of 7 years 0 months to 7 years 4 months;

(iii) have no physical handicap, behaviour problem or sensory defect, such as would impede manipulation of materials or sight;

(iv) to be currently enrolled in a grade one course of schooling after spending the previous year in a preparatory course.

3.1.2 Selection details

From the population within the school that met the described criteria, the 24 Ss (12M, 12F) were randomly selected. Six male Ss and six female Ss were then randomly selected from within this sample (see Appendix 1 for details) and allocated at random to one of two learning conditions:

*Sample size and representation of only one school place obvious limitations on the external validity of this study's findings. The sample, however, met the requirements for the statistical analyses used. It also provided for similar background school experiences.

(a) a learning condition in which the teaching apparatus used, signalled feedback by covert physical linkage. This was designated the CPL condition;

(b) a condition in which the teaching apparatus used, signalled feedback by an overt physical linkage clue. This was designated the OPL condition.

3.2 Statistical analysis and design

Independent variables of the study were:

(i) learning condition: CPL and OPL; and

(ii) sex: male and female.

Dependent variables consisted of:

(i) the number of errors occurring during the learning phase;

(ii) the number of six consecutively correct association responses to any one stimulus pair during immediate retention testing which occurred at the conclusion of the learning phase;

(iii) the number of six consecutively correct association responses to any one stimulus pair during delayed retention testing which occurred 24 hours after the learning phase.

For the purposes of this study six consecutively correct association responses to any one stimulus pair is referred to as a criterion response in further discussion; i.e. one criterion response consists of six consecutively correct association responses to any one stimulus pair.

A two-way analysis of variance was used to analyse all

dependent variables. Because of the withdrawal of one subject during the experiment unequal numbers existed in the cells of the 2 x 2 design (see Figure 5).* In view of this, an unweighted means solution for ANOVA was used.

N=23		LEARNING CONDITION	
		CPL	OPL
SEX	M	$n = 6$	$n = 5$
	F	$n = 6$	$n = 6$

FIGURE 5 Allocation of subjects

When the independent variable of learning condition is considered the study closely resembles Design 6 by Campbell and Stanley (1966). This is illustrated in Figure 6.

R	X (CPL)	O_1	O_2	O_3	X (CPL)	O_4	O_5	O_6
R	(OPL)	O_7	O_8	O_9	(OPL)	O_{10}	O_{11}	O_{12}

FIGURE 6 The design of the study

Note:

1. Observation points 1, 4, 7 and 10 represent learning phases.

*The subject withdrew because of illness, having contracted mumps. A replacement subject was not found because there were insufficient days remaining in the school year for a new 'run' of the experiment (involving 4 days) to occur.

At each of these points the recording of incorrect and correct responses during five learning trials took place.

2. Observation points 2, 5, 8 and 11 represent the immediate retention testing phases. At each of these points measurement of the S's responses during six testing trials took place. The stimuli for the testing trials were presented on Test Cards (3 trials) and in a Test Book which enabled 3 trials to be completed.

3. Observation points 3, 6, 9 and 12 represent the delayed retention testing phases. They were a repeat of measurement procedures used during immediate retention testing but occurred approximately 24 hours later.

3.3 Apparatus

3.3.1 Teaching apparatus

The teaching apparatus developed to test the hypotheses owed much to the criteria used by Jackson (1972) in the development of his Learning Association Modules. It was to be used in the learning of association responses and met the criteria now described.

(i) Ease of manipulation by infant school children of average intelligence;
(ii) ability to attract their interest;
(iii) requiring a motor response format for the matching task;
(iv) displaying the stimuli to be matched in a manner which permitted rapid systematic variation of presentation order during the experiment;

(v) possessing a built-in feedback system which indicated to the subject immediate knowledge of correct or incorrect responding to a matching task without any intervention by the experimenter;

(vi) able to be made in two forms varying only on the covertness or overtness of the feedback system;

(vii) providing a learning situation which was largely subject controlled (i.e. the S could make his own choices as to which stimuli he would associate as well as the order in which he associated them);

(viii) controlling the number of stimuli presented.

Two forms of the apparatus which met the described criteria were designed. They were similar in all characteristics but one; the overtness or covertness of the built-in feedback system. Before describing these distinctive features, features common to both types of apparatus will be discussed.

Features common to both forms of apparatus

(i) The apparatus consisted of two interlocking sections, one section containing a space into which the jutting-out shape of the second section fitted when the two sections were placed side-by-side.

(ii) The two sections of the apparatus measured 10 x 5 x 1 cms when interlocked.

(iii) Each section was built up to a similar height then painted white.

(iv) Each section of the apparatus provided an area (5 x 3.5 cms) for displaying stimuli to be matched. The two display areas were at the extreme left and extreme right of the apparatus when two sections were interlocked.

(v) The apparatus was designed with variations in interlocking combination. (See Appendix 11 for illustrations of the ten variations used in this study.) No part of one combination would interlock successfully with a part from any other combination. Only correct association responses resulted in sections interlocking.

(vi) Built in to the apparatus was a guide to aid manipulation of the sections during interlocking. Each section had a 5 mm straight edge on both sides of the physical linkage section. Once the manipulator had positioned the jutting-out section even slightly into the space area of another section, the straight edges facilitated the interlocking operation by restricting vertical movement.

(vii) A black line, 3 mm in width along the lower edge of each section, facilitated correct orientation of the stimuli. Self-adhesive tape was used to produce this feature.

(viii) The apparatus was designed to be positioned on a horizontal surface.

The distinctive features of the two forms of apparatus which met the general criteria will now be described.

Form 1 signalled correctness without a distractor by containing

covert physical linkage. This form of apparatus was designated CPL.

(a) Distinctive feature of the CPL apparatus

The covert physical linkage did not allow the learner to anticipate which two sections would (or would not) interlock successfully. It was therefore not possible for the learner using this type of apparatus to anticipate which two stimuli signalled one another, other than by observation of the stimuli to be associated and/or a trial and error procedure. (See Figure 7.)

The covertness of the physical linkage clue was possible because of the four layers of wood comprising each section of the apparatus. Whilst the top and bottom layers (i.e. layers 1 and 4 respectively) were identical in size and shape, layers 2 and 3 differed considerably both to layers 1 and 4 and to each other. Layer 3 contained the physical linkage clue. Layer 2 contained one section extended in length so as to conceal the physical linkage clue from the manipulator's view. The remaining section of layer 2 was correspondingly shortened. Appendix III illustrates how this form of apparatus was designed and assembled.

Form 2 of the apparatus signalled correctness by an overt physical linkage in the form of a jigsaw fit. This form was designated OPL apparatus. The overt physical linkage was in fact a distractor.

(b) Distinctive feature of the OPL apparatus

The overt physical linkage clues allowed the learner to

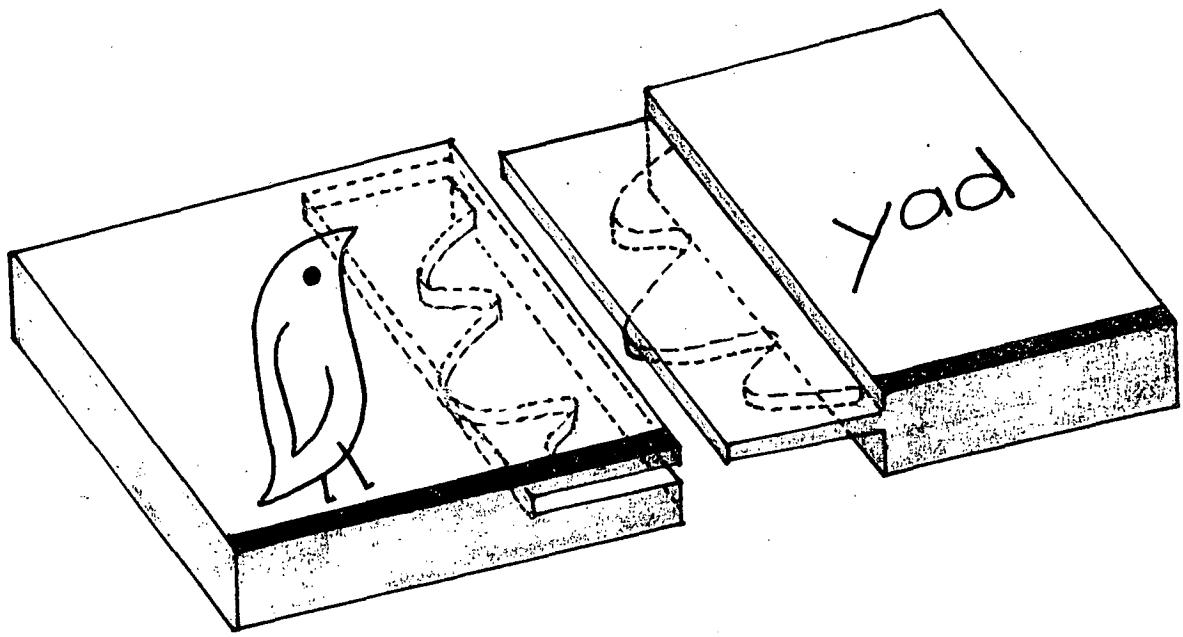

FIGURE 7 CPL apparatus

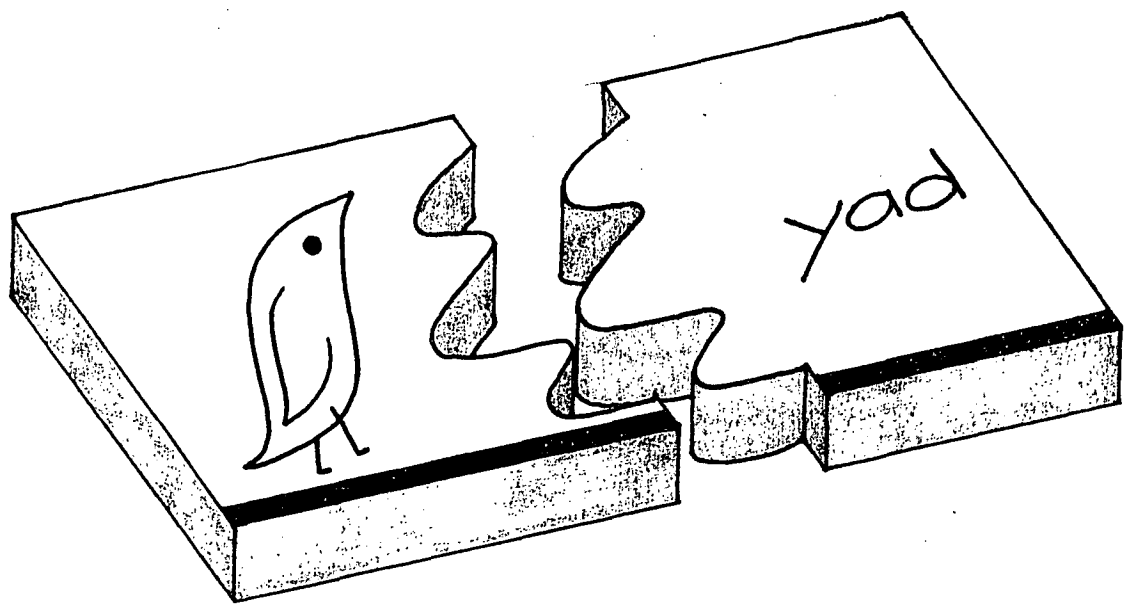

FIGURE 8 OPL apparatus

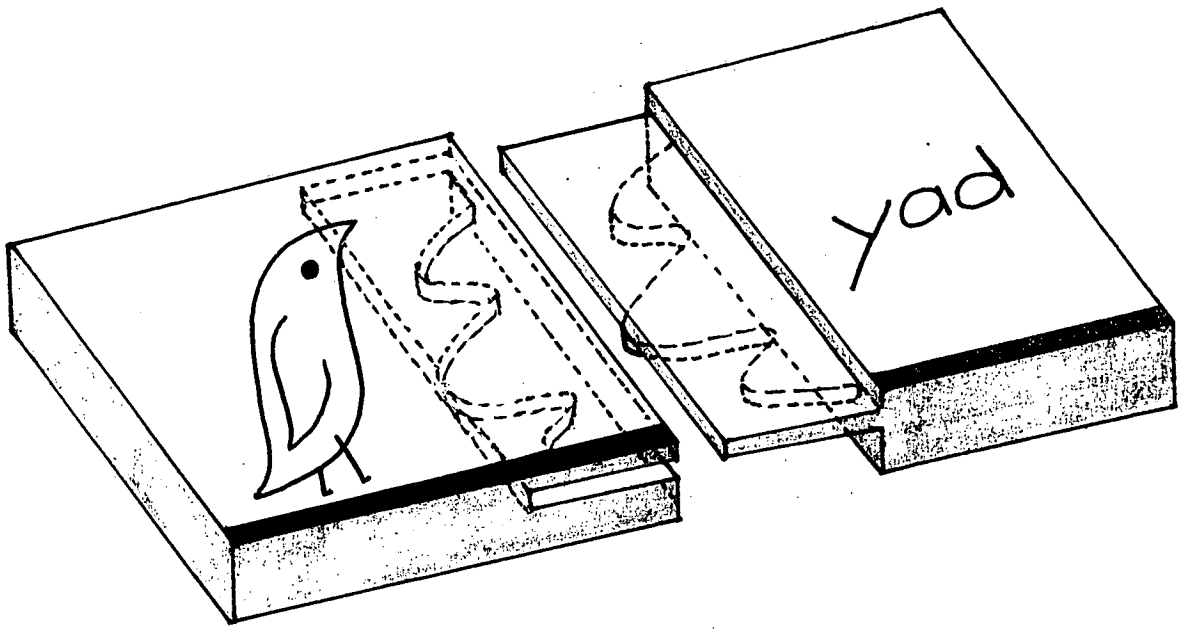

FIGURE 7 CPL apparatus

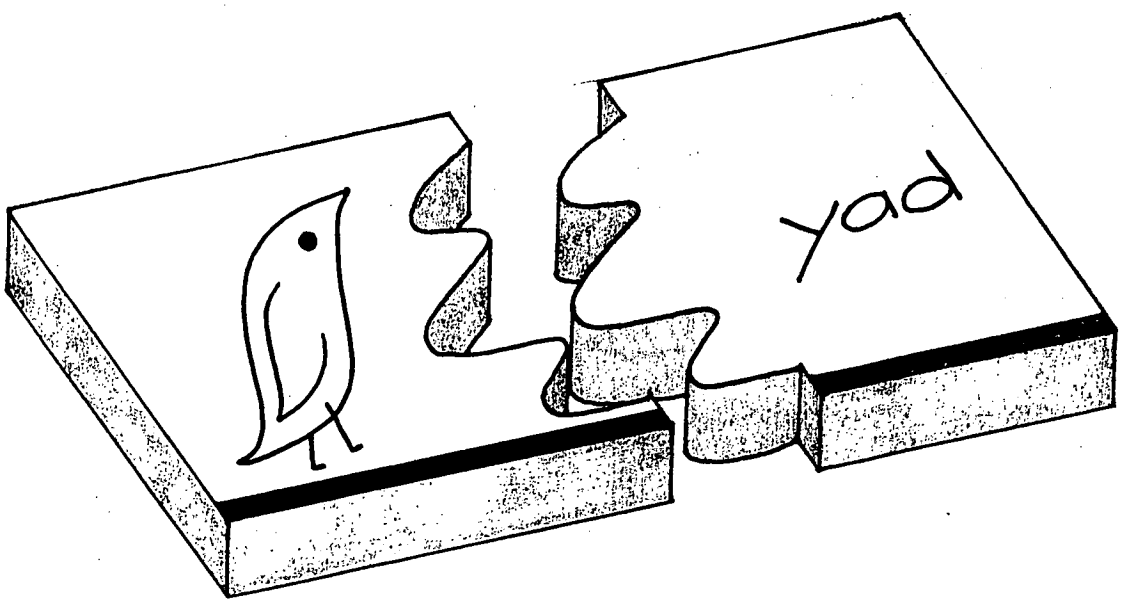

FIGURE 8 OPL apparatus

anticipate which two sections would (or would not) interlock successfully. OPL apparatus therefore allowed the learner to anticipate which two stimuli signalled one another by attention to physical linkage clues irrelevant to the learning task, as well as by observation of the stimuli to be associated and/or a trial and error procedure.

The four layers of wood comprising each section of this type of apparatus were identical in size and shape. All layers contained the overt physical linkage clue. When assembled, the apparatus was identical with the overall dimensions of the CPL apparatus but it differed distinctively in that the physical linkage clue was not concealed from the manipulator's view. Such clues are common in jigsaw type puzzles frequently used in association learning situations. (See Figure 8.)

3.3.2 The stimuli to be learned

The learning task consisted of eight experimental stimulus pairs of novel words and novel creatures. Novel stimuli were used to ensure that all Ss were presented with a learning task involving unknown stimuli. In this way any association learning which resulted could be attributed to the experimental condition and not past experience. It is acknowledged that the novel creatures used by Berko (1958, 1961) in research relating to the generalization of grammatical rules by young children, stimulated the design of those used in this study. Several bore a marked resemblance.

The stimuli were illustrated in black on white self-adhesive labels (see Figure 9). These labels were positioned on the display

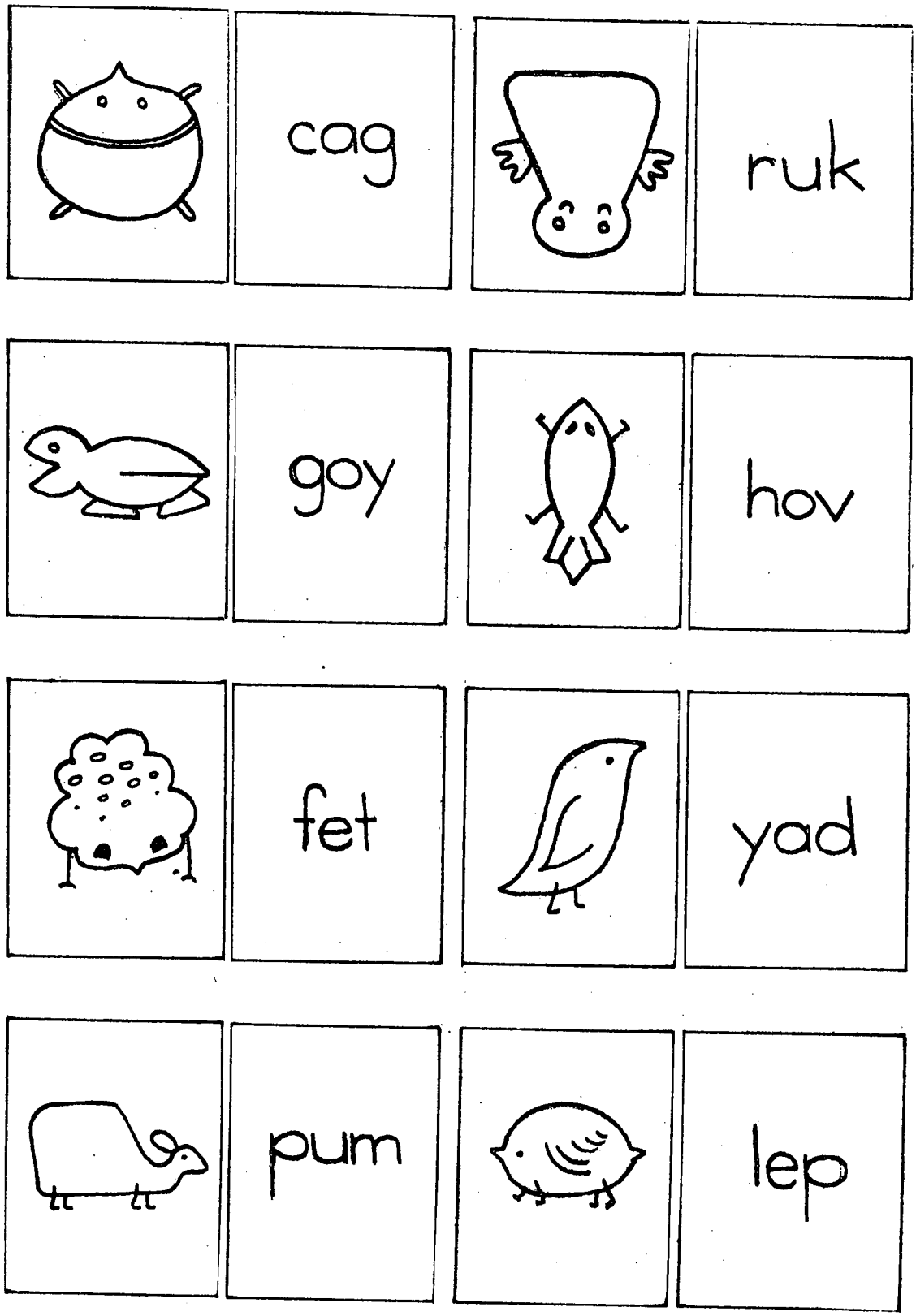

FIGURE 9 The stimuli to be learned

areas of the apparatus. Picture stimuli were placed on the extreme left; word stimuli, on the extreme right. The actual size of the stimuli used is shown in Figure 9.

(a) Criteria for the selection and design of eight picture stimuli

(i) The picture stimuli consisted of novel creature-like objects having no known word referent. These creatures had four characteristics, namely;

a) a basic outline shape

b) legs or flippers

c) eyes

d) one additional distinguishing feature on the body shape

(ii) Side-on and front-on views of the creatures were equally represented. Of the creatures viewed side-on, two faced east, and two west. Of those creatures viewed front-on, two had eyes at the top, and two at the bottom.

(iii) Leg or flipper numbers were equally represented. Half of the creatures had four legs, the other half, two. Of the creatures having four legs, two had legs underneath the body, and two in four different directions around the body. Of the creatures having two legs, two had stick-like legs, and two, flippers.

(iv) The basic outline shape of each creature was represented only once.

(v) The additional distinguishing feature on each creature (see (i)d above) was represented only once. The eight features were namely: a wing, tail detail, a band, spots, eyebrows, an ear, stripes, and a straight line.

(vi) The creatures could each be clearly illustrated in an area less than 4.5 x 3.5 cms.

(b) Criteria for the construction of eight novel words

(i) All words followed the consonant-vowel-consonant (c.v.c.) pattern and were meaningless to the Ss. (i.e. No word had a known concrete or abstract referent.)

(ii) Eight of the nine possible word shapes when constructing c.v.c. words, were used. These shapes are illustrated in Figure 10. The shape not used (i.e. [ ]) was eliminated because its lack of extender letters (e.g. d, k, g, p) would make it more highly discriminable than the eight shapes which all contain one or two extender letters, if used in conjunction with the other shapes.

(iii) The vowels a, e, o, and u were represented twice. The vowel i was not used because of its highly discriminable shape when compared with the fore-mentioned vowels. The vowels were positioned so that no vowel was represented in both one shape plus the mirror image of that shape.

(iv) The upper extender letters of the alphabet (b, d, f, h,

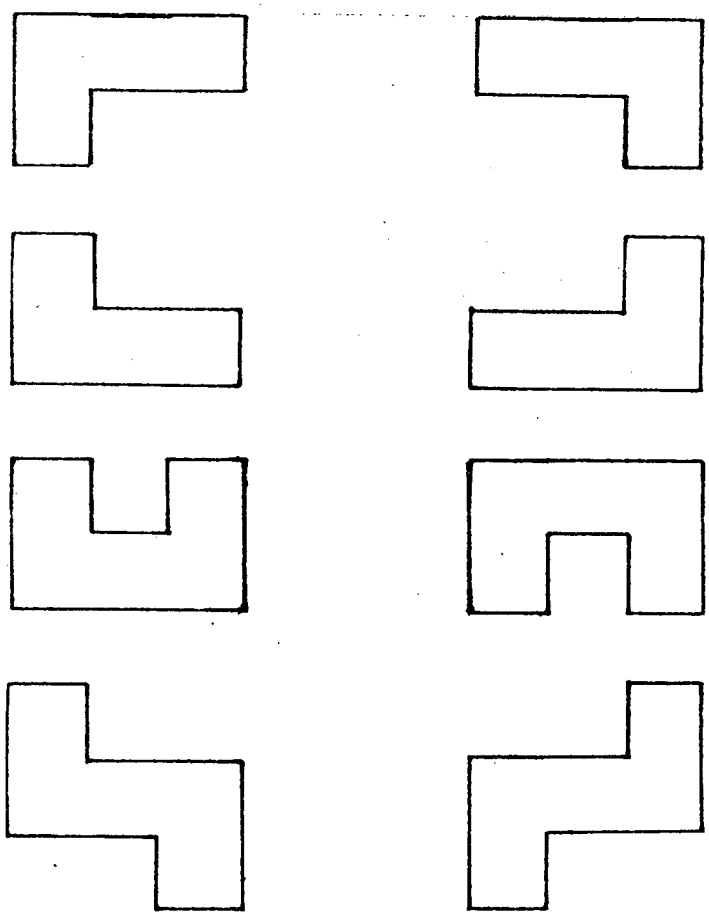

FIGURE 10 The eight word shapes used in the construction of novel c.v.c. words

k, l, t) with the exception of b were represented once. As only six letters of this type were required, b was eliminated because of its low discriminability with d.

(v) The lower extender letters of the alphabet (g, j, p, q, y) with the exceptions of j and q were represented twice as six letters of this type were also required. The letter j was eliminated because of its high discriminability factor, and q, because of its low

discriminability with p.

(vi) Only four of the small consonant letters of the alphabet (c, m, n, r, s, v, w, x, z) were required. The letters c, m, r and v were selected and represented once. The letter n was eliminated because of its low discriminability with m and u; the letters s, w, x and z, because of their complex formation making them highly discriminable.

(vii) The lower extender letters represented twice were used once as the initial consonant and once as the final consonant.

(ix) No letter was used twice in the same word and furthermore, the words containing a similar consonant did not contain a similar vowel.

(c) Criteria for the labelling of a particular picture stimulus

As both types of stimuli were novel in design, the designation of picture and word could have been determined randomly. However, two criteria were considered, these being:

(i) creatures facing similar directions were not associated with words containing similar vowels, and

(ii) creatures having similar numbers of legs/flippers were not associated with words containing similar vowels.

As a consequence of these two criteria, pictures were allocated the names which appear in Figure 9.

3.3.3 Apparatus used during the familiarization phase

Two pieces of CPL apparatus (having variations 9 and 10 physical linkage clues) were used to display the stimuli illustrated in Figure 11. Two pieces of OPL apparatus (also having variations 9 and 10 physical linkage clues) displayed identical stimuli. This equipment was used with each S during the familiarization phase of the experiment.

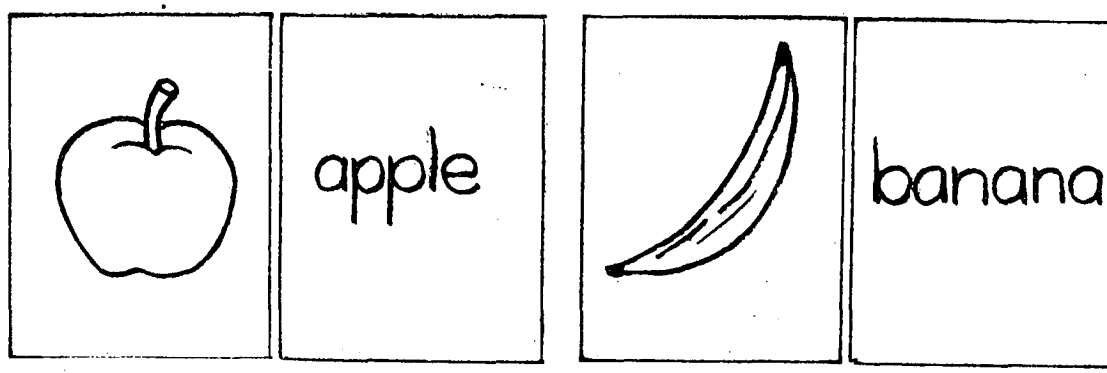

FIGURE 11 Stimuli used during familiarization phase

3.3.4 Testing materials

The method of assessing the difference between the two learning conditions was by measuring

a) the number of criterion responses made in association tasks involving the same stimuli but with materials containing no feedback system during:
   (i) an immediate retention testing phase occurring immediately after a learning phase, and
   (ii) a delayed retention testing phase occurring 24 hours later,

and b) the number of errors occurring during a learning phase.

Each testing phase (i.e. both immediate retention and delayed retention) contained two measuring procedures; one, a measurement of the correct response tested by a matching procedure, and the other a measurement of the correct response tested by a pointing procedure. The first procedure was assessed via cards and the second, via a test booklet.

Each of the testing materials,

a) test cards,

b) test booklets, and

c) data recording sheets,

will now be described.

a) Test cards

Each novel picture stimulus and each novel word stimulus was displayed on a cardboard rectangle (5 x 3.5 cms) having no physical linkage clue. The stimulus was illustrated in black on a white background (see Figure 12). A black line, 3 mm in width along the lower edge of each card, facilitated correct orientation of stimuli by Ss. These cards were used during both testing phases of the study. The cards were divided into two sets of four stimulus pairs and are referred to as Set 1 and Set 2. Reasons for this division will be discussed when organizational factors are presented. (Note: Any reference indicating the division of the eight stimulus pairs into two sets during the following descriptions will be explained, also at that stage.)

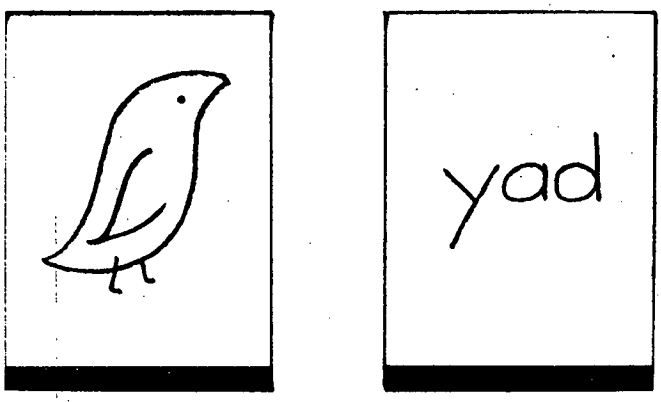

FIGURE 12 Example of test cards from Test Cards Set 1

b) Test booklets

Two spirax books (18 x 12.5 cms), one for each set (1 and 2) were prepared for use during the testing phases of the study. These books were designed to facilitate ease of display and to maintain a standard order of presentation to each S. The book for each set contained the picture and word stimuli of that set. Details relating to the composition of the books are as follows.

Each book contained twelve pages. A page contained one picture stimulus centrally positioned and the four word stimuli of the set; one in each corner.

Each of the four picture stimuli of the set to which a book belonged was displayed three times in the book. The order of picture stimulus presentation was randomly determined with the one restriction that all picture stimuli of the set were displayed once, before a second display of any picture stimulus, and that all stimuli were displayed twice, before a third display of any stimuli. The random order followed was 314212342413 after each picture stimulus within a set had been randomly allocated a number. (See

Figure 14 showing the numbers allocated to stimuli.)

The word stimuli were positioned 3 cms from the top and lower edges of a page. The word stimuli on the left hand side of a page commenced 2 cms from the edge; the stimuli on the right hand side finished 2 cms from the edge. Each page contained a different positional display of the four word stimuli of the set. These twelve displays represented three basic arrangements (1243, 1342, 1423) randomly selected from the six possible arrangements. Four variations of each arrangement were presented while maintaining the stimuli in each corner. (i.e. Beginning in the left hand top corner and moving clockwise, the words represented by each number were displayed in the basic arrangement. This was Variation 1. In Variation 2 all words were moved clockwise to the adjacent position. This clockwise movement was maintained in Variations 3 and 4). The order of basic arrangement display as well as that of variations within, was determined randomly with the restriction that all four variations of one arrangement were displayed once before any second arrangement was displayed; furthermore, that all second arrangement variations were displayed before any third arrangement was displayed. A sample page from Test Booklet Set 1 is illustrated in Figure 13. (See Appendix IV for illustration of the random order followed in displaying the word stimuli. The numbers represent the stimuli as illustrated in Figure 14.)

c) Data recording sheets

Two sheets, one for each set (1 and 2) were prepared to minimize the amount of actual recording during the experiment and to facilitate the analysis of data. On each of these sheets were

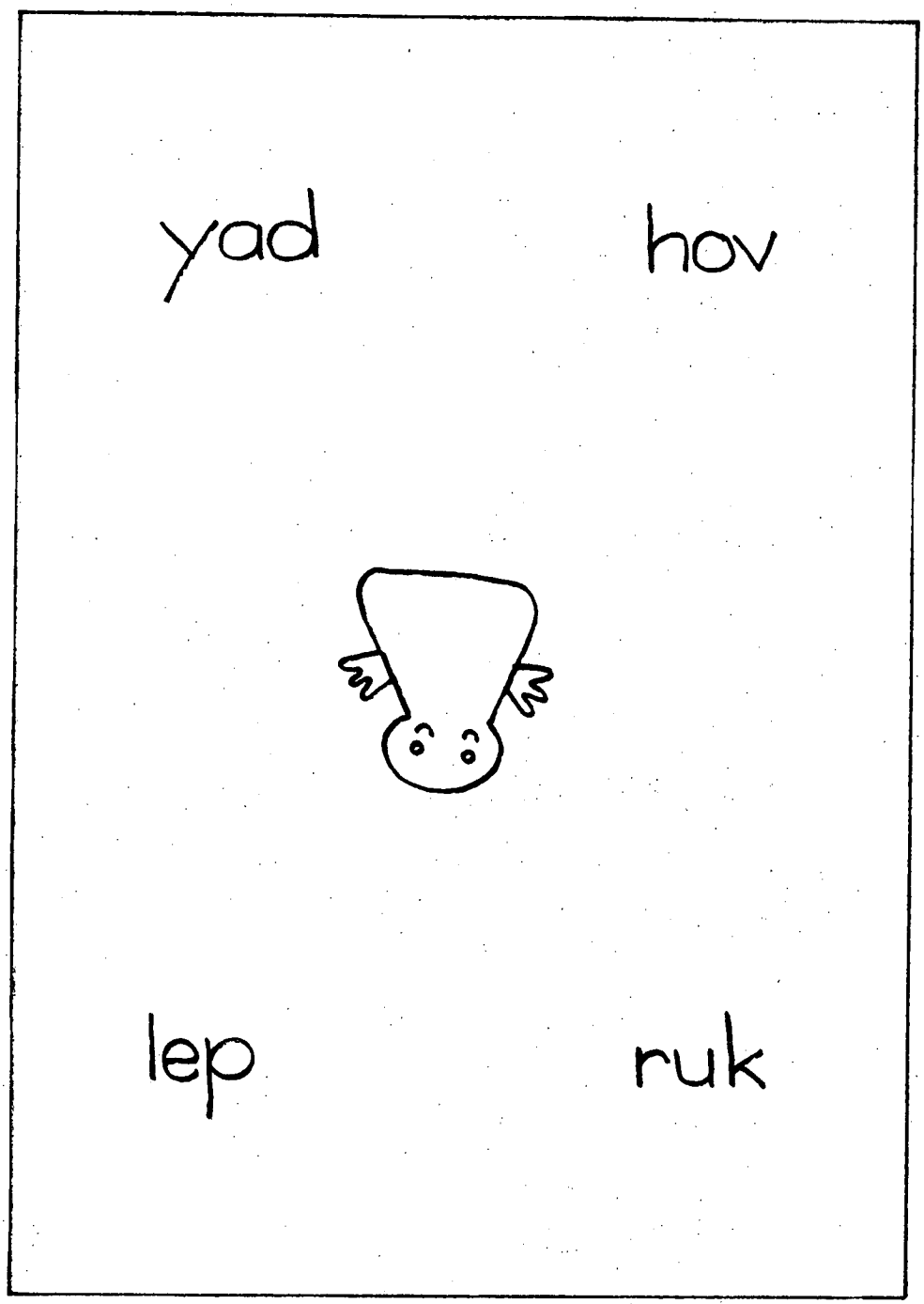

FIGURE 13 Sample page from Test Booklet Set 1

recorded both incorrect and correct matching responses during,

(i) the five learning trials of the learning phase, and

(ii) the six testing trials of a) immediate retention testing, and b) delayed retention testing.

The order of stimuli on the prepared sheets is not necessarily the order in which the Ss matched the stimuli during learning and testing phases. Two recording sheets (Set 1 and Set 2) were completed for each S during the experiment. (Appendices Va and Vb contain samples of the recording sheets.)

3.3.5 Factors relating to organization

1. The experiment was conducted at the school attended by all Ss. A classroom not in use by the school's staff was made available for the entire duration of the experiment. It provided suitable environmental conditions for the study, not least of which was its familiarity with the young Ss.

2. All procedures with each S were carried out by the writer and conducted on a one-to-one basis. The detailed recording of responses necessitated this.

3. A co-observer was used throughout to assist with timing and the routine of bringing Ss from the classrooms to the experiment room. This facilitated administration and made it possible to conduct individual sessions with all 24 Ss on each day of the experiment.

4. During experimental procedures the co-observer (C),

experimenter (E), and S were seated around a cluster of four desks. The E was positioned on the right hand side of the S and was opposite the C.

5. It was planned that all Ss would participate in the experiment on each of four consecutive days. Equal numbers from the four cell groupings of the study (CPL males, CPL females, OPL males, OPL females) were randomly selected and allocated to order of participation as far as the program of the school allowed. (Ss' order of participation is shown in Appendix VI.)

6. The four sessions with each subject were organized as follows:

Session 1
- (i) familiarization
- (ii) learning (for stimulus set 1 or 2)
- (iii) immediate retention testing (for the stimulus set introduced during learning)

Session 2
- (i) delayed retention testing (for the stimulus set introduced during Session 1)

Session 3
- (i) learning (for the alternative stimulus set)
- (ii) immediate retention testing (for the alternative stimulus set introduced during this session)

Session 4
- (i) delayed retention testing (for the stimulus set introduced during Session 3)

The familiarization, learning, immediate retention and delayed retention testing phases will be described in detail elsewhere in this chapter.

7. The eight pairs of stimuli were displayed on eight pieces of CPL apparatus as well as on eight pieces of OPL apparatus having interlocking combination variations 1 to 8 (see Appendix II). The interlocking combination variation for identical novel stimuli displays on both CPL and OPL apparatus, was the same. (Appendix VII lists the novel stimuli displayed on each variation of interlocking combination.)

8. The total population of eight stimulus pairs to be learned was introduced to each S. However, four stimulus pairs only were introduced and/or tested in any one session. The reason for this will now be described.

   A learning situation was required which would be neither too difficult for all Ss to experience some degree of success, nor on the other hand, lacking challenge. Small pilot probes were carried out prior to this study to determine the number of stimulus pairs which infant school children could reasonably be introduced to in any one session of learning. The children involved in the pilot probes were not Ss of the study but were of similar mental age. Results indicated that when 6 or 8 stimulus pairs were introduced, the task was too difficult for all children. This was evidenced by the consistently high number of

errors during learning and low measures of success during testing immediately following the learning experience. As a consequence of this it was deemed necessary to divide the stimuli into two presentation sets which necessitated two learning sessions per subject.

To facilitate administration the eight stimulus pairs were allocated into two discrete sets (1 and 2) for the entire experiment. Equal discriminability was maintained as far as possible, the criterion for allocation being as follows:

Each set contained equal representation of vowels, extender letters, positional views of creatures, eye location, and leg/flipper numbers.

Figure 14 illustrates the set division. It is noted that Set 2 is the only set which contained a letter twice represented (i.e. g). It was not possible to avoid having one set contain a lower extender letter represented twice because of criteria (v) and (vii) relating to the construction of words. However, this possible source of confusion had equal representation in each cell grouping of the study's design, therefore it was not considered a major limitation.

Half of the Ss within each cell grouping received the stimulus sets in the order 1 2; the remaining half, in the reverse order. Order was randomly allocated. (Appendix VI lists the order for each S.)

The instructions and format closely adhered to during the

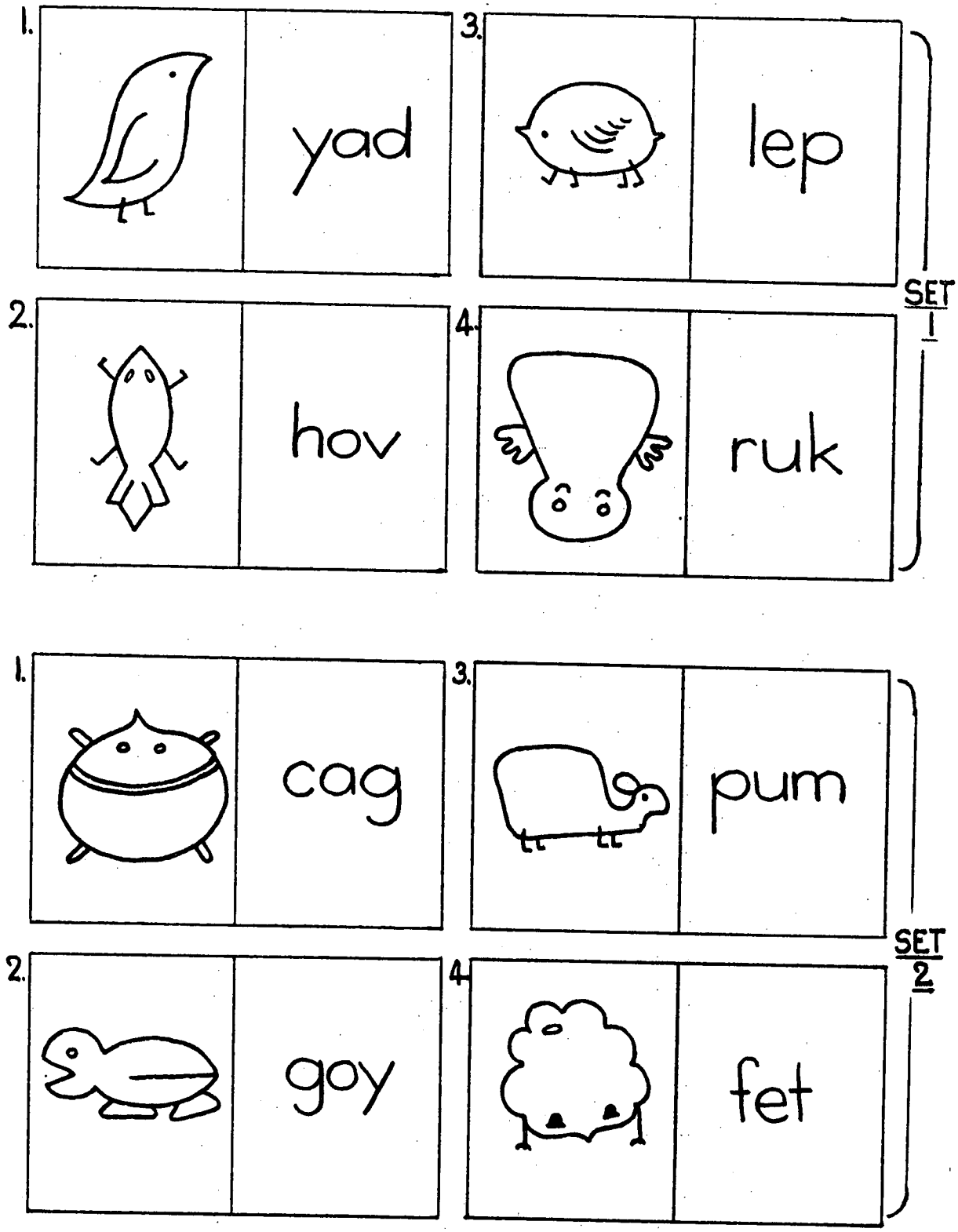

FIGURE 14 Stimuli to be learned (Sets 1 and 2)

experimental sessions have not been placed in the appendices but are included in the following discussion. It was considered important that the reader be familiar with them before proceeding to the discussion of the study's results contained in the next chapter.

(a) Familiarization phase

At the commencement of the first session with each S a brief time (2-5 mins) was allocated to a familiarization phase. Its purpose was two-fold:

(i) To establish some degree of rapport, interest and cooperation.

(ii) To familiarize the S with both types of teaching apparatus (OPL and CPL) and the purpose of the study.

The following instructions and format were closely adhered to during the latter part of the familiarization phase with each S. (A row of four dots indicates a time when the E waited for a response from the S.)

The E said, *I have two kinds of games to help people learn the names of things.* E placed OPL familiarization apparatus displaying the name apple and its matching picture flat on the desk in front of the S and took the interlocked sections apart while the S observed. *This is like one of the games.* E pointed to the picture stimulus. *Do you know what this is? .... Yes, that's right.* E pointed to word. *Do you know what this says? .... Yes, it's the name apple.* (If S did not respond or did not respond correctly, the E told the S the correct name.) *The picture of apple and the*

name apple belong together. See if you can fit them together. .... That's right! Now, take them apart. We're going to see what happens if we try and put the name apple with a picture of a banana. E placed the OPL familiarization apparatus section displaying the banana picture in front of the S. *You try it. Does it fit with the name apple? .... It won't fit because they don't belong together. In this game you always know quickly whether you have the right pictures and names together. If you don't have the right name for a picture, the pieces won't fit. If you do have the right name for a picture, the pieces fit together.*

The E removed the OPL familiarization apparatus from the desk then placed CPL familiarization apparatus displaying the name apple and its matching picture in front of the S. The E separated the sections of the apparatus while the S observed. *This is like the other kind of game to help people learn the names of things. It looks a little bit different from the first game but we play it the same way. You put these together and see if they fit. .... Do they? .... That tells us you have the right name and picture together.* E placed the CPL familiarization apparatus section displaying the banana picture in front of the S. *Try and fit the name apple with the banana picture. .... Why doesn't it fit? .... Yes, they don't belong together.*

There's one more thing to know about playing these games. E pointed to black line along lower edge of stimuli. *See this black line? It shows you the bottom of the word and picture. The pictures and words we use in the game today will be ones you've never seen before. If you make sure the black line is at the bottom you'll know the pictures and words are the right way around.*

The E removed familiarization apparatus from the desk in preparation for immediate commencement of the learning phase.

(b) Learning phase

The procedure was identical for all subjects irrespective of learning condition. The only variable between learning conditions was the type of physical linkage clue contained in the teaching apparatus. For illustration purposes only, OPL teaching apparatus displaying stimulus set 1 is used in the following procedural outline which was followed during the two learning sessions with each subject.

The E handed the S a piece of cardboard (approx. 30 x 40 cms) and said, *Hold this in front of your face while I put your new game on the desk.* E positioned the four interlocked pieces of the OPL teaching apparatus displaying stimulus set 1 in a vertical row, flat on the desk in front of the S. A space approximately 2 cms in width separated each interlocked pair. (The order of this first presentation was identical to that used in the random allocation of picture stimuli in the test booklet for Set 1.) The E said, *Now we're ready for your new game.* E took the cardboard away from the S's face. *Here are some strange little creatures and their names.* Immediately after saying this the E separated the interlocking pieces by approximately 20 cms, keeping picture stimuli on the S's left and word stimuli, on the S's right. The positions of all sections were then quickly rearranged in the following manner.

The interlocking piece nearest the S on his left, was placed at the furthest position in front of the S on his left. The

piece furthest in front of the S on his right, was positioned nearest to the S on his right. All sections were slightly moved during this operation so that four picture stimuli were opposite four word stimuli, but any one picture was not opposite its associated name.

While the rearrangement procedure was being carried out, the E said, *I'll mix them all up so that you can play the game and learn the names of the creatures. Let's make sure the black line is at the bottom of all the pictures and names. .... OK, it's ready for you to play now.*

(As the S attempted to match the stimuli the E recorded next to the appropriate picture stimuli on Data Recording Sheet 1 a cross for each error response and a tick for each correctly matched response. The small pilot probes conducted prior to this study indicated that the rapidity of the S's responding would prevent the recording of any further information relating to error responses. Video-recording would have provided access to additional information but unfortunately, circumstances prevented the use of such recording during this study.)

The S was permitted to play the game at his own pace. If he had positioned his display of correctly matched stimuli close together so as to be visually confusing, the E would have said, *Let's put the ones you've matched like this,* then proceeded to demonstrate an orderly vertical presentation. (No S required intervention of this kind during the study.)

When the S had correctly matched the four pairs of stimuli the

E said, *That's good work. I can see you know how to play the game.* Immediately the E separated the interlocked pieces, following a similar rearrangement procedure to that described previously. While re-positioning the pieces the E said, *Now I would like you to play the game again. We'll do it five times altogether.*

The learning procedure described was repeated until the S played the game a total of five times. These five games (or five learning trials) constituted the treatment phase of a session. Immediately following the fifth learning trial the teaching apparatus was removed in preparation for commencement of the immediate retention testing component.

(c) Time as a variable

The variable of time was uncontrolled during the learning phase. Each subject participated in and completed the five trials at his own pace. Reasons for permitting unlimited time were as follows:

1. The learning phase was designed to resemble a typical infant classroom situation; one in which a child participates and completes a task involving the matching of associated stimuli. It was therefore considered essential to allow for any individual differences in working pace that might have existed, to prevent pressure on the young subjects and possible frustration at not being able to complete a task. Each subject completed the five trials of the learning phase prior to immediate retention testing which was conducted immediately following treatment.

2. The planned procedures for any one session could reasonably be expected not to overestimate the attention and concentration span of the young subjects; particularly so in the one-to-one situation of this study. Pilot probes had indicated that no session was likely to extend twenty minutes.

3. Had rigid control of the time variable been built in to the design, several other variables would have become considerably more difficult, if not impossible to control. A hypothetical situation will be discussed to illustrate this point.

   If a total time ceiling restriction had been placed on the five trials constituting the learning phase;

   a) Ss failing to complete the five trials would have had
      (i) less exposure to correctly matched stimuli,
      (ii) less success experience because of fewer correct responses (i.e. less than 20),

   than those Ss completing the learning phase within the time limit. These factors may have affected test performance and results, directly and indirectly respectively.

   b) Ss completing the five trials of the learning phase would have had
      (i) either, greater exposure to correctly matched stimuli and particularly so if the matched stimulus pairs of the fifth trial had remained within view till the time limit

expired,

or

greater exposure to correctly matched stimuli but combined with less overall exposure to the novel stimuli if the matched stimulus pairs of the fifth trial had been removed immediately following completion,

(ii) greater success experience because of the completion of five trials (e.g. 20 correct responses),

than Ss failing to complete the learning phase within the time restriction.

The design could have been such as to allow continued playing of the 'game' (i.e. more than five trials) till the time limit expired for fast working Ss. However, under such conditions these Ss would then have had

(i) a greater number of situations in which to test and consolidate any learning that had occurred,

(ii) potentially greater exposure to correctly matched stimuli,

(iii) potentially greater success experience because of an increased possible overall number of correct responses.

On the other hand, the design could have been such that after completion of the fifth trial the stimuli pairs were separated, rearranged and exposed to the S but were not to be matched by him. In such a situation the S would have

similar exposure time for the novel stimuli but his final visual memory picture would not have been that of correctly matched pairs and may in some cases have been quite a lengthy exposure to unmatched stimuli.

In view of these considerations the decision was made not to control the variable of time during the learning phase. This decision resulted in the control of the following factors:

a) amount of success experience. All Ss would make 20 correct responses during the learning phase.

b) amount of exposure to a set of correctly matched stimulus pairs (i.e. on six occasions; the initial display plus at the conclusion of each of the five learning trials). As described elsewhere, these pairs were separated and rearranged immediately following completion of a trial.

c) number of games or trials in which the S could test and/or consolidate any association learning.

d) the final visual memory picture prior to the immediate retention testing phase for all Ss was that of correctly matched stimulus pairs.

It was planned that the time each S spent in matching four stimulus pairs during each trial would be measured unobtrusively by the co-observer and recorded. Timing commenced immediately after the E said, *OK, it's ready for you to play now,* and finished when the S had interlocked the final stimulus pair of a set. The findings

of this investigation are reported and discussed in the results chapter.

(d) Means of testing the difference between the learning conditions

Measurement of any association learning that may have occurred during the learning phase was conducted at two points of time for each stimulus set (1 and 2). These were namely:

(i) immediately following the conclusion of the fifth trial of the learning phase. Measurement conducted at this point is referred to as immediate retention testing;

(ii) measurement procedures conducted during immediate retention testing were repeated the following day. These are referred to as delayed retention testing. All delayed retention testing was conducted at points of time not less than 21 hours but not greater than 24 hours, after immediate retention testing.

The procedures followed during each phase of testing will now be described.

(i) Immediate retention testing

Identical procedures were followed for all Ss in both learning conditions. For the purpose of illustration only, the testing apparatus for stimulus set 1 is used in the following outline.

Testing trials requiring a matching response

Immediately following the removal of the teaching apparatus from the S's desk at the conclusion of the learning phase, the

E handed the S a piece of cardboard and said, *Now we're going to see whether that game helped you to learn which creatures and names belong together. Hold this in front of your face while I put some cards on your desk.* E positioned the eight cards of Test Cards Set 1 flat on the desk in front of the S. Cards displaying picture stimuli were on the S's left; those displaying word stimuli, on the S's right. A space of approximately 20 cms in length separated picture and word stimuli, whilst a distance of approximately 2 cms separated cards of similar stimulus type. The actual display prepared was identical to that which faced the S after the rearrangement of the first display of novel stimuli during the learning phase. (Note: the S was not confronted with a display of correctly matched stimuli when the cardboard was removed, as occurred during the learning phase. Instead, the S was confronted with a display of stimuli which had no picture opposite its associated name.)

The E said, *Now we're ready.* E took the cardboard from the S. *Here are some cards showing the same creatures and names that you've been playing games with. See if you can put the right creature with its name.* No indication was given by word or gesture as to incorrectness or correctness of response. The S was permitted to change any response he made during this stage and worked at his own pace. The E recorded the final actual word stimulus responses next to the appropriate picture stimuli on Data Recording Sheet 1. If a S questioned the E as to the accuracy of his responding during this stage, the E replied, *I'm only writing down what you have just done. Later on I'll check this paper to see whether or not you had the*

right ones together. (All Ss participating in this study spontaneously paired all test cards whether or not appearing confident of their learning of all stimulus pairs. The recording of the four actual word responses allowed for thorough rechecking of data by independent assistants and provided increased information.)

When the S had matched all the cards, or, indicated that she/he had matched all she/he knew, the E said, *I'd like you to have two more tries at putting the right creatures and names together.* While saying this the E separated the pairs of cards, following a similar rearrangement procedure to that described previously. The E then said, *OK, have another try.*

This procedure was repeated once more so that the S matched Test Cards Set 1 a total of three times. The cards were removed following the recording of the S's responses on the third testing trial.

Testing trials requiring a pointing response

The E now placed Test Booklet Set 1 on the S's desk and said, *This book has the same creatures and names in it that you have been learning.* The E opened the book to its first page and continued, *Point to the name you think belongs to this picture.* No indication was given by word or gesture as to incorrectness or correctness of the S's response. The S was permitted to change his response and worked at his own pace. The E recorded the final actual word stimulus response to the picture stimulus on the first page, next to the appropriate picture stimuli on

Data Recording Sheet 1. The E then turned to the second page and repeated the instruction, *Point to the name you think belongs to this picture.* This procedure was repeated until all twelve pages of the book had been displayed once and the S's responses recorded. (When it became obvious to the E that the verbal instruction to point was not needed, the instruction was omitted.) Upon completion of the book, a total of three presentations of each novel picture stimulus of Set 1 had occurred. At this stage the immediate retention testing phase concluded.

Six testing trials, three with Test Cards and three during Test Booklet administration, had occurred. Any S who responded correctly to any one stimulus pair consistently throughout each of these six testing trials was considered to have made a criterion response.

(ii) Delayed retention testing

Approximately 24 hours after immediate retention testing for a stimulus set (1 or 2), identical tests were administered to each S. Delayed retention testing followed a similar procedural outline to that of immediate retention testing with the following exception.

Prior to the S entering the classroom the E positioned Test Cards Set 1 as described for immediate retention testing and covered the display with cardboard. After greeting the S the E said, *Today we are going to see if you can still remember what you learned when you played the games yesterday. See if you can put the right creature with its name.* The E then removed the cardboard.

The procedure followed from this point was identical to that described previously for immediate retention testing.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Hypothesis I

That feedback in the form of covert physical linkage (CPL) (characteristic of a number of auto-instructional devices) will produce more effective learning of association responses by normal infant school children than feedback in the form of overt physical linkage (OPL) (also characteristic of numerous instructional aids).

Hypothesis II

That there will be no significant sex difference in the effective learning of association responses for both the CPL and the OPL feedback conditions.

Hypotheses I and II were tested by measuring the effective learning of association responses and comparing the results for the main effects; namely, learning condition (CPL and OPL) and sex, respectively. As described in this study previously, the criterion for effective learning of an association response was said to have occurred when a subject made six consecutively correct association responses to one stimulus pair during the six testing trials of a testing phase. During the following discussion, six such responses to any one stimulus pair are referred to as a criterion response (i.e. the 6 responses constitute one criterion response). In this chapter the results for the immediate retention testing phase, administered immediately after the learning phase, will be presented firstly followed by those of the delayed retention testing, occurring approximately 24 hours later. As Annett (1969) points out; delayed retention could be a more sensitive indicator of the persistence of learning. Presentation of results and discussion for

both Hypotheses I and II will proceed simultaneously.

4.1.1 Immediate retention testing

Appendix VIII contains raw data relating to the number of criterion responses made by each subject during this testing phase. A 2 x 2 ANOVA was applied to the mean number of these criterion responses resulting in the analysis shown in Table 1.* The mean number of criterion responses for each cell group during this phase is shown in Figure 15.

Table 1

2 x 2 analysis of variance for sex and learning condition during immediate retention testing

	SS	df	MS	F	P
S	4.1285	1	4.1285	2.7080	0.1162
LC	9.9063	1	9.9063	6.4978	0.0195 *
S x LC	7.5571	1	7.557	4.9569	0.0382 *
Error	28.9666	19	1.5245		
Total	50.9565	22	2.3162		

Examination of the main effects in Table 1 reveals no significant sex difference in the mean number of criterion responses. However, there was a significant difference when considering the learning condition variable (p=0.0195 *). A significant interaction effect between the main variable is also evident (p=0.0382 *). From Figure 15 it is seen that;

(i) The CPL condition produced significantly more learning in males than the OPL condition (p=0.0037 **). One cogent

*See footnote on p.66.

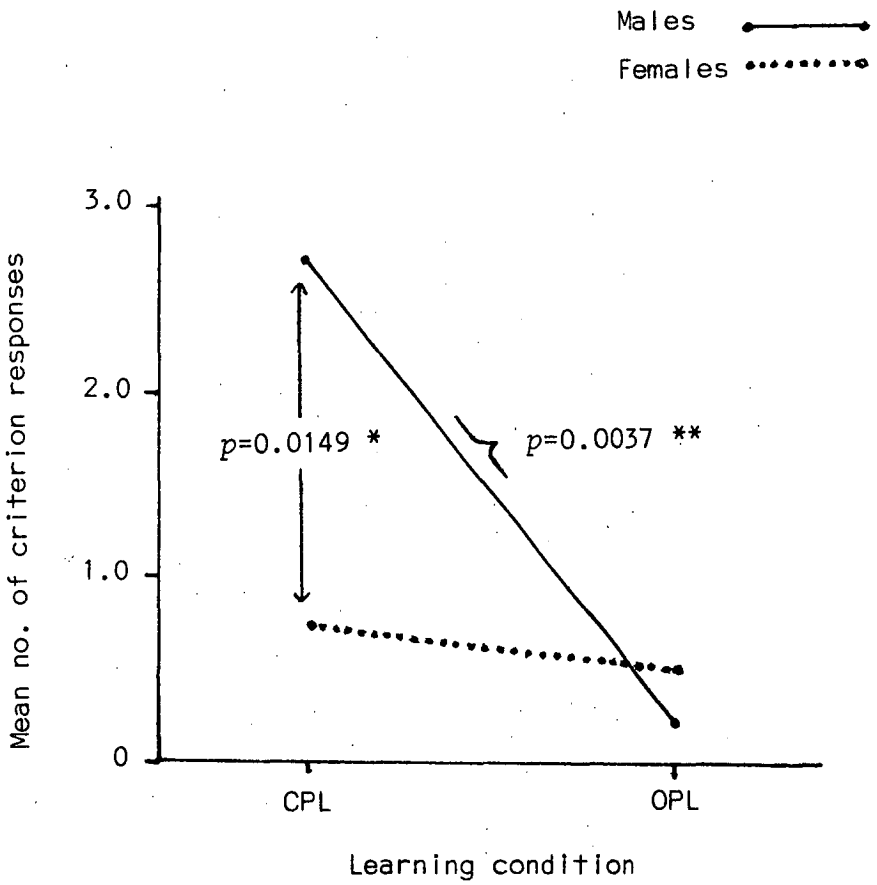

FIGURE 15 Mean no. of criterion responses during immediate retention testing

Although not stated in each instance throughout this chapter, an unweighted means solution for ANOVA was used because of unequal cell numbers. Norton's study (1952) cited by Keppel (1982, p.86) indicates that small cell numbers and unequal cell sizes, providing there are strongly significant results, overcome the problems of normality and homogeneity.

explanation for this difference is that the CPL condition, having no attention distracting physical linkage clues as in the OPL condition, facilitated learning in males by forcing attention to the task relevant stimuli. In other words, the amount of raw physical information entering the sensory store of the CPL subjects' memory was considerably less than that entering the sensory store of OPL subjects thus making the selection of information for transferral into short-term memory store (Loftus & Loftus, 1976) a more complex task for OPL subjects.

(ii) No significant difference, however, in learning by females occurred between the CPL and OPL groups. The mean number of criterion responses for both groups was low, being 0.66 and 0.5 respectively. This result, when compared to the highly significant difference between male CPL and OPL groups, is intriguing. Some tentative explanations will be offered at this stage and a more definite explanation stated after all results of the study have been presented, for some of the latter results have a definite bearing on this explanation.

Firstly, the study may have been biased in its use of constructive-type teaching apparatus in view of evidence showing that young males prefer this type of play material and activity (Farrell, 1957; Honzik, 1951). In other words; it may have been an attitude of the female mind towards the actual task of physically manipulating wooden blocks in this study that affected their attention and concentration under both learning conditions. It must be noted at this stage that although evidence shows

distinct male preference for certain toys and activities there is no conclusive evidence that young females have distinct toy preferences (Pulaski, 1970; Ward, 1968) or do not choose to play with male stereotyped toys such as blocks. A purely subjective comment relative to this possible explanation is that no subject, male or female, displayed any overt sign to the experimenter, co-observer, or regular teaching staff indicating lack of interest in participating during the entire experiment.

Secondly, the actual physical manipulation of the apparatus may have been more difficult, thus requiring greater effort and concentration for females, and if so, perhaps this resulted in less attention to the task relevant stimuli under both learning conditions than in males. It could be assumed that male preference for blocks (Farrell, 1957) and constructive-type toys would have produced more frequent rehearsal of manipulative skills during preschool years by male subjects. This may have produced greater facilitation in the manipulative skills required with the experimental apparatus. However, it was observed that female subjects did not appear to display greater difficulty than males in manipulating the apparatus.

A third explanation involves the view that the sexes have distinct modality preferences; males, visual and females, auditory. At present such a view has not been clearly demonstrated. However, <u>if</u> females did, in fact, have a definite auditory modality preference and males, a

visual preference, certain experimental conditions of this study might be considered as male biased. For example, although the instructions were given orally the stimuli to be learned were presented only visually. Furthermore, during both the learning and testing phases only visual stimuli were presented and manual responses required. On the other hand, one major aspect of the experiment might be considered as female biased, that aspect being the use of associative stimuli involving novel words. Two theories (which have as yet not been conclusively demonstrated in the literature) will be offered to support this notion of female bias. Firstly, the transferral of the raw visual sensory information to the short-term memory store may be recoded into an acoustic form (Conrad, 1964; Fontana & Evans, 1980; Wickelgren, 1965), in which case females may have been advantaged. Secondly, it is theorized that the verbal ability of the young female is superior to that of males (Sherman, 1978). In view of these considerations, to conclude that the experiment was male biased may be gross oversimplification of the actual situation in that it ignores some possible major areas of female bias.

A fourth tentative explanation for the similar low results of female learning under both conditions when compared with CPL males' superior learning to OPL males will now be offered. It relates to the view of Garai and Scheinfeld (1968) who consider that females exhibit greater social needs than males whose achievement needs are directed more to successful task accomplishment.

Whilst there is some research evidence indicating that females are no more affected than males by a lack of social reinforcement (Allen, Spear & Lucke, 1971; Spence, 1972), if in fact Garai and Scheinfeld's view is correct, the experiment for this study may have affected female achievement orientation negatively. It may have been that lack of social reinforcement (verbal comments of encouragement or praise, physical contact) by the experimenter during the learning process affected female achievement negatively whilst having little or no effect on that of males.

Finally, in view of evidence supporting greater anxiety in young females than young males (Douglas & Rice, 1979; Jersild & Holmes, 1935), female learning may have been more affected by a conscious or subconscious anxiety than that of males. The total experimental situation with its relatively unfamiliar apparatus, personnel and novel stimuli may have caused interference in the attention of anxious subjects to task demands (Wine, 1971). Closely tied in with this explanation is the effect that the unfamiliar aspects, possible anxiety producing agents, may have had on the curiosity and exploration of the young subjects. There is some evidence to suggest that young males demonstrate a greater degree of curiosity and exploratory behaviour than young females (Baumrind & Black, 1967; Daehler, 1970). Whilst there is also contradictory evidence (Yando, Zigler, & Gates, 1971) one might tentatively hypothesize that if females are less inclined to explore new situations this may have

affected their learning in this study. The experimenter, however, observed no overt signs of anxiety in any subject, male or female.

(iii) The CPL condition produced significantly more learning in males ($\bar{x}$ number of criterion responses, 2.66) than females (0.66) (p = 0.0149 *). Explanations for this result have just been presented with the previous observation and will not be repeated.

(iv) No significant difference in learning occurred between the male and female OPL groups ($\bar{x}$ number of criterion responses; 0.2 and 0.5 respectively). The probable explanation for this low result is the minimal attention to task relevant stimuli by OPL subjects. The physical linkage clue clearly acted as a major distractor for both males and females. It was observed that both male and female subjects readily used the available clue when selecting stimuli to be matched. An objective measurement of this observation will be discussed when the results of errors are presented. At this stage it will be noted however, that the objective evidence clearly demonstrates that OPL subjects made very few errors. They obviously were distracted by the physical linkage clue and largely concentrated on that irrelevant physical information. They solved the perceived problem but not the relevant one.

4.1.2 Delayed retention testing

From the raw data of Appendix VIII a 2 x 2 ANOVA was applied to the mean number of criterion responses during delayed retention

testing.* The results are shown in Table 2. Figure 16 contains the mean number of criterion responses for each cell group during this testing phase.

Table 2

2 x 2 analysis of variance for sex and learning condition during delayed retention testing

	SS	df	MS	F	P
S	2.6682	1	2.6682	1.3471	0.2601
LC	18.8587	1	18.8587	9.5212	0.0060 **
S x LC	5.5253	1	5.5253	2.7896	0.1112
Error	37.6333	19	1.9807		
Total	64.8695	22	2.9486		

Table 2 indicates no significant sex difference in the mean number of criterion responses. It also shows that the difference in mean number of criterion responses between learning conditions is highly significant (p=0.006 **). Significantly more learning occurred under CPL conditions. No significant interaction was evident. The results of t testing between the cell groups (see Figure 16) indicate that during delayed retention testing:

(i) as in immediate retention testing, the CPL condition produced significantly more learning in males than the OPL condition (p=0.0038 **).

(ii) as in immediate retention testing, no significant difference in learning by females occurred between the CPL and OPL conditions. It is of interest to note, however, that whilst the mean number of criterion

*The separate analyses used for immediate and delayed retention testing are consistent with Research Hypothesis I.

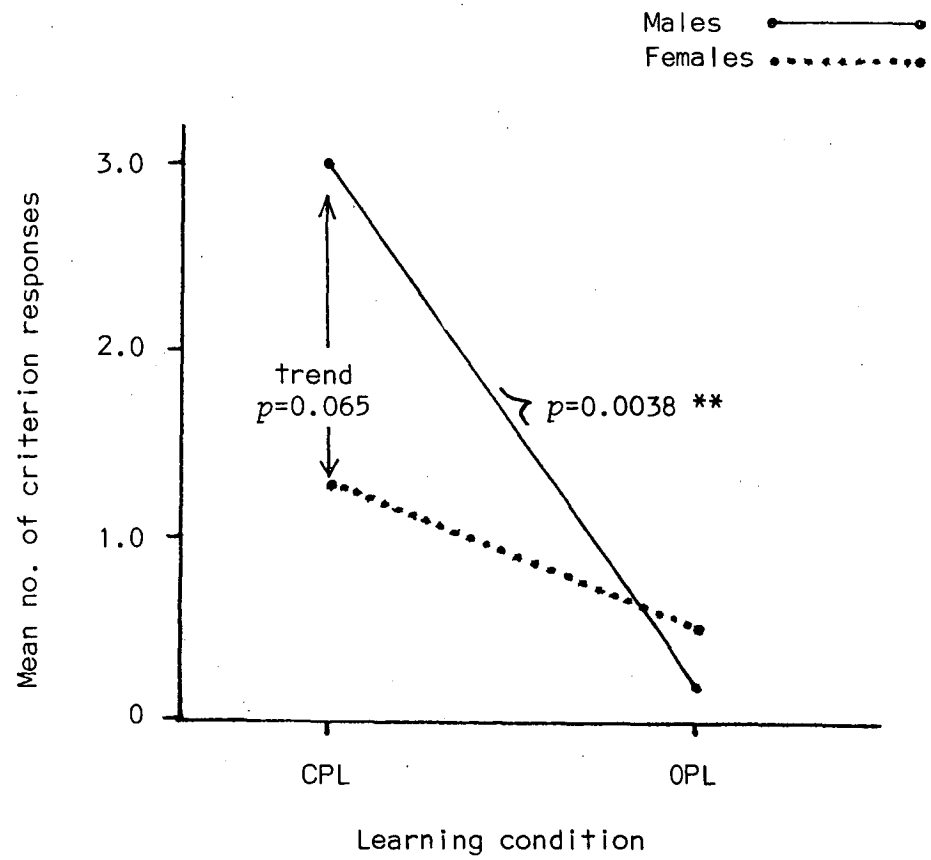

FIGURE 16 Mean no. of criterion responses during delayed retention testing

responses under the OPL condition remained at 0.5 (as during immediate retention testing), under the CPL condition the mean rose from 0.66 (at immediate retention testing) to 1.33. It appears that it is this increase which contributes largely to the nullifying of the significant interaction effect evident during immediate retention testing. Consolidation of learning during the initial testing phases had obviously occurred to some extent despite the absence of any feedback from the learner's external environment. This increase had occurred only under the CPL condition and will be referred to when the conclusions of this study are made.

(iii) The difference in mean number of criterion responses between CPL males and females was not significant although results indicate a trend towards significance (p=0.065) consistent with the findings of immediate retention testing. It could be argued justifiably however, that the results indicate a trend away from significance rather than towards and this presents an interesting and important point. It is noted that the means of both groups (CPL males and females) increased over those of immediate retention testing. The mean for CPL females (as mentioned previously) increased from 0.66 to 1.33 criterion responses; the mean for CPL males, from 2.66 to 3.0. A 2 x 2 ANOVA was applied to the mean number of criterion responses occurring only during delayed retention testing. (See Appendix IX for table showing the analysis of main effects and Appendix X for figure showing mean number of criterion responses for each cell group.) Examination of the main effects reveals no

significant sex difference in the mean number of criterion responses. However, there exists a significant main effect for the learning condition variable (p=0.0178 *). Restated, the CPL condition resulted in an increased number of criterion responses during delayed retention testing which was significantly greater than the minute (almost absent) increase occurring under the OPL condition. It is obvious that learning of associative stimuli, the objective of the teaching apparatus, had been facilitated by the CPL feedback condition during the learning phase to a significantly greater extent than by the OPL feedback. It was also clear that not all learning facilitated by the CPL condition was immediately measurable; for both CPL males and females showed an increase in learning 24 hours later. Considerable care had been taken not to familiarize the regular teaching staff of the school with details of the experiment and no subject was permitted to record any information relating to novel stimuli seen. In view of this it appears that no rehearsal of the novel stimuli could have occurred other than that stored within the subjects' memories. While during the learning phase task relevant information had entered the short-term memory store and in some 18 instances long-term storage under the CPL condition, it was equally obvious that little task relevant information had been transferred from the transient sensory store to short-term store under the OPL condition.* Figure 17, illustrating the mean number of criterion responses during both immediate and delayed retention testing, quite clearly depicts these results.

*Furthermore, under the latter condition, in only 3 instances was task relevant information transferred to long-term storage (see Appendices VIIIc and VIIId).

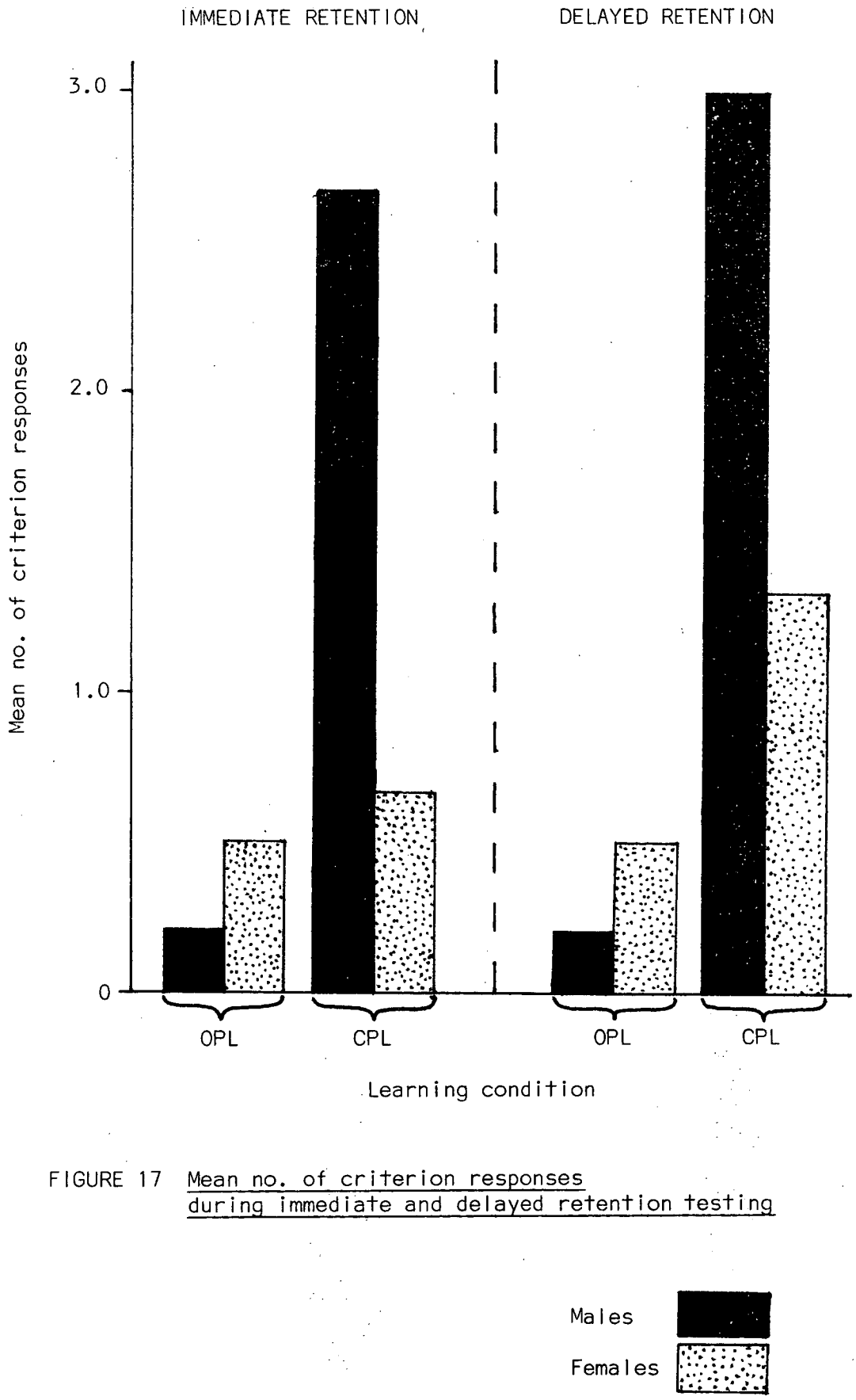

FIGURE 17 Mean no. of criterion responses during immediate and delayed retention testing

(iv) as in immediate retention testing, no significant difference in learning occurred between males and females under the OPL condition. The mean number of criterion responses for both groups remained identical to that of immediate retention testing (OPL males, 0.2, OPL females, 0.5).

4.2 Hypothesis III

That more errors will occur during the learning process with CPL conditions than with OPL conditions.

This hypothesis was tested by comparing the mean number of errors occurring during the learning phases (Sessions 1 and 3) for each cell group. Errors during the learning phases were recorded separately for each of the five learning trials (or games) occurring within a learning session so that a more detailed probe could also be conducted. Appendix XI contains the raw data relating to the number of errors made by each subject.

Firstly, the mean number of total errors will be compared. A 2 x 2 ANOVA was applied to the number of errors during total learning, resulting in the analysis displayed in Table 3. The mean number of errors during the learning phases for each cell group is shown in Figure 18.

When examining the main effects, it is evident that there was not a significant difference in the number of errors made by males and females. However, a highly significant difference (p=0.0000****) existed between learning conditions with CPL subjects making

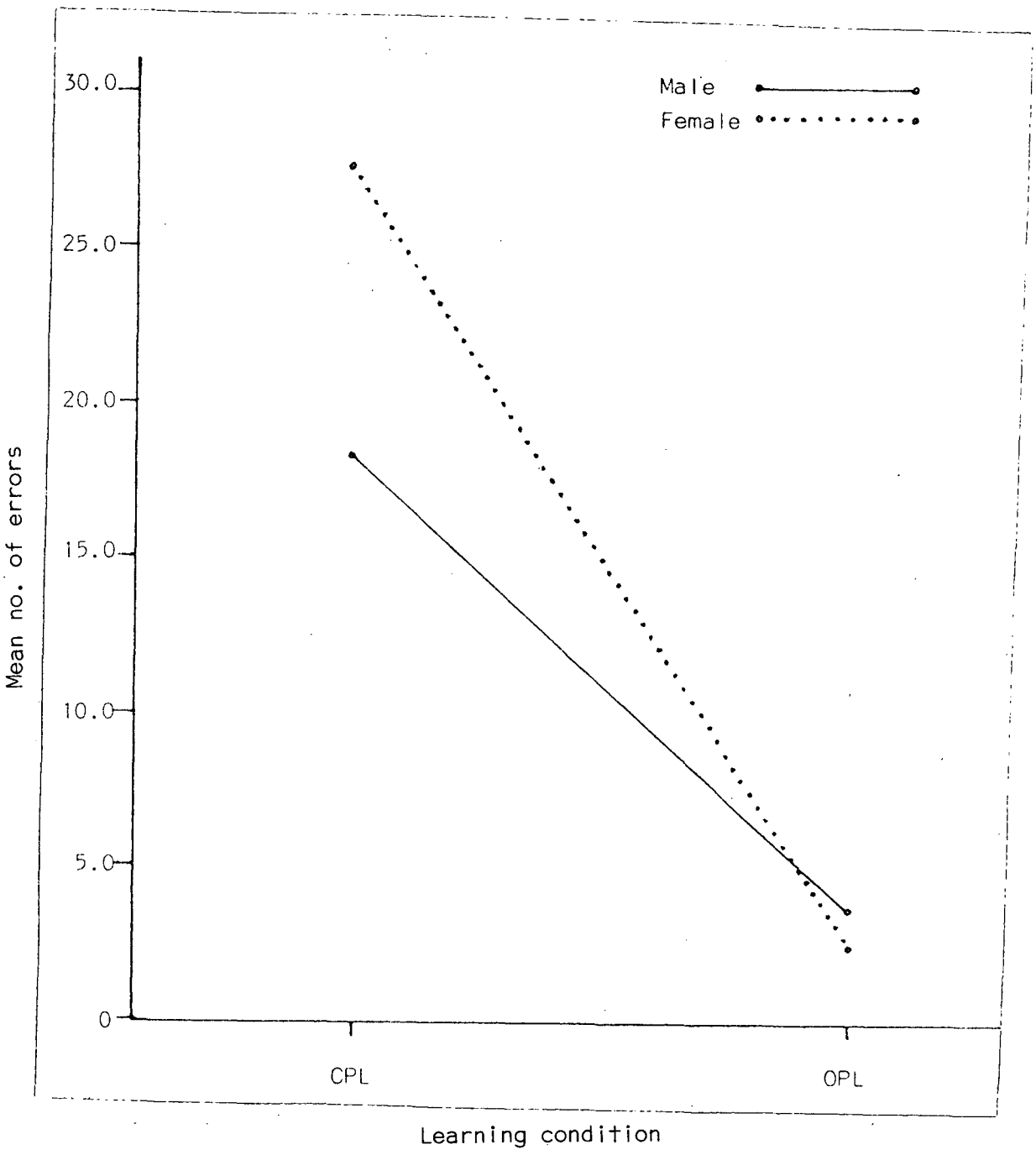

FIGURE 18 Mean no. of errors during the learning phases of Sessions 1 and 3

Table 3

2 x 2 analysis of variance for sex and learning condition

(Total errors during learning)

	SS	df	MS	F	P	
S	104.8396	1	104.8396	2.2983	0.1459	
L	2236.4587	1	2236.4587	49.0282	0.0000	****
S x LC	155.5063	1	155.5063	3.4090	0.0804	
Error	866.7000	19	45.6157			
Total	3395.6521	22	154.3478			

significantly more errors than OPL subjects. It is unlikely that this difference was due to any factor other than the type of feedback used during learning. No significant interaction effects were evident although there was a slight trend towards significance (p=0.0804).

Explanations for these results will be withheld until discussion relating to the mean number of errors for each of the learning trials is presented. The more detailed investigations provided significant information which was concealed in the combined data for the analysis of total errors during learning.

Table 4 shows the mean number of errors for each cell group during the five trials of the combined learning phases (Sessions 1 and 3). These results are depicted in Figure 19.

Table 4

Mean numbers of errors for each cell during the five trials of the combined learning phases in sessions one and three

Cell	Trial				
	1	2	3	4	5
CPL Males	2.92	1.58	2.0	1.75	0.83
CPL Females	3.67	2.83	3.25	2.08	2.0
OPL Males	0.7	0.2	0.4	0.3	0.2
OPL Females	0.42	0.25	0.08	0.08	0.5

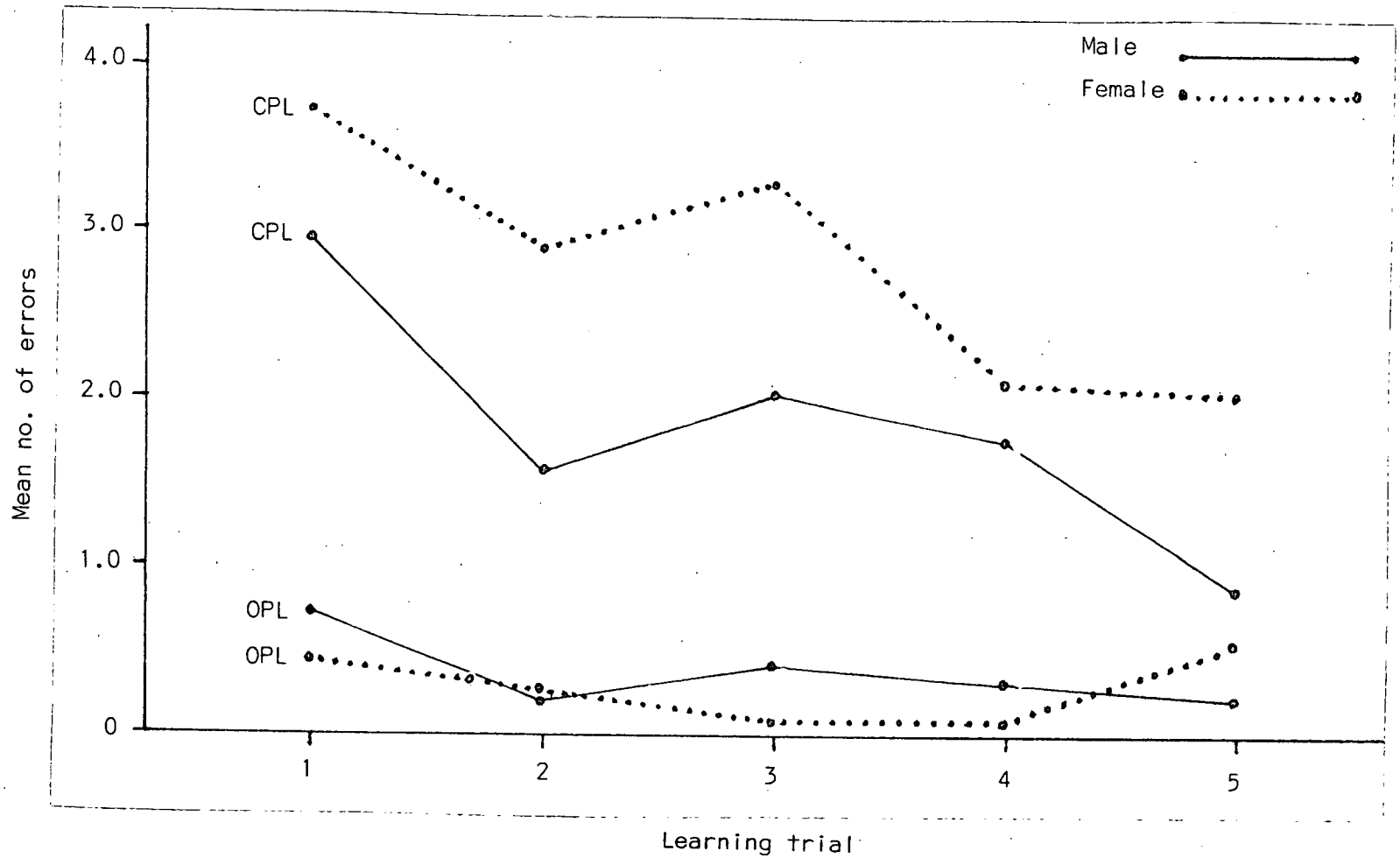

FIGURE 19 Mean no. of errors for each of the five learning trials

The following points relate to information evident in Figure 19.

(i) CPL male and female groups both made considerably more errors than their OPL counterparts during trials one, two, three and four. However in trial five, whilst the difference between CPL and OPL females remained quite evident ($\bar{x}$ errors CPL, 2.0; OPL, 0.5), the difference between CPL and OPL males was not so apparent ($\bar{x}$ errors CPL, 0.83; OPL, 0.2). The most reasonable explanation for this is the obvious one; that CPL males had learned more associative responses during the preceding trials than CPL females and were therefore making considerably less errors than CPL females at this stage. Furthermore, because of their learning CPL males' errors over the trials of the learning phase had decreased to the extent that there was very minimal difference in the number of errors made by them and OPL males, who had made few errors throughout by utilizing the available physical linkage clue. Several tentative explanations have already been offered

in this chapter as to why learning for CPL males differed to that of CPL females. It is recalled that criterion responding during immediate retention testing for CPL males was significantly higher than that of CPL females as well as that of OPL groups. During delayed retention testing CPL males maintained their superiority over OPL groups and established it by increasing their number of criterion responses somewhat. However, and this is important to note; there was not a significant difference between criterion responding for CPL males and females during delayed retention testing. The learning by CPL females was not all obvious at the conclusion of the learning phase. Quite a degree of consolidation was apparently still occurring within their memories and as Figure 19 shows, the mean number of errors they were making in the final and fifth learning trial indicates there remained at that stage a considerable amount of novel stimuli to be sorted out and associated firmly in their minds. Relevant to this first observation is the second.

(ii) CPL male and female groups followed a similar pattern in the mean number of errors during the five trials but males had a consistently lower mean than females. This difference was perhaps most evident in trial two ($\bar{x}$ errors CPL males, 1.58; CPL females, 2.83) and in the final trial ($\bar{x}$ errors CPL males, 0.83; CPL females, 2.0). The graph lines for CPL groups, indicating a quite similar pattern of an initial decrease in errors for trial two, followed by a slight increase then a decline, illustrate this point (see Figure 19). Any of the tentative explanations

offered during the discussion for Hypotheses I and II could likewise be offered to explain the consistently higher number of errors made by CPL females to their male counterparts. However, in view of the similar number of errors made by OPL males and females, it is obvious that females experienced no greater difficulty than males in manipulating the apparatus.

One might argue that the more errors a subject made, the more opportunities he had for observing and learning the stimuli and this appears to be a valid argument when comparing the errors and learning under the two feedback conditions. However, although CPL females made more errors during learning than CPL males, it was the learning by CPL males that was superior to CPL females.

(iii) No significant difference existed between OPL male and female groups during any trial. The mean number of errors for both groups remained consistently low (less than 0.8). It was obvious that OPL subjects selected the information which they considered was most meaningful and helpful to them in completing the task. Whether they did this to avoid failure, to ensure success, to avoid a challenging abstract task, or because the physical linkage clue made it difficult for them to attend to the abstract stimuli is not known. What is known however is the fact that attention was given to the overt clue. No other explanation could be offered in the circumstances for such a consistently low error response.

Prior to the final conclusions of this study being made, the results of the investigatory probe into time taken by subjects to complete the learning phase will be presented. The findings have considerable bearing on the conclusions made.

4.3 The time variable during learning

Reasons for permitting unlimited time during the five learning trials have been described in the method chapter. As an investigatory probe however, the timing of each trial for all subjects was conducted by a co-observer. The results of this investigation will now be reported and discussed.

Examination of the time variable was conducted in two parts. Firstly, the mean trial time during the combined learning phases of sessions one and three was analysed. Secondly, the mean trial times for each of the five learning trials were studied. The raw data relating to the time taken by the Ss to complete each trial is shown in Appendix XII. A 2 x 2 ANOVA was applied to the average trial time during total learning. Table 5 contains the results of this analysis. The mean trial time for each of the cell groups is shown in Figure 20.

It is evident from Table 5 that highly significant differences in mean trial time exist for both main effects; sex (p=0.0015 **) and learning condition (p=0.0000 ****). Furthermore, there is a trend towards significant interaction (p=0.0596).

The mean trial time of female subjects was significantly

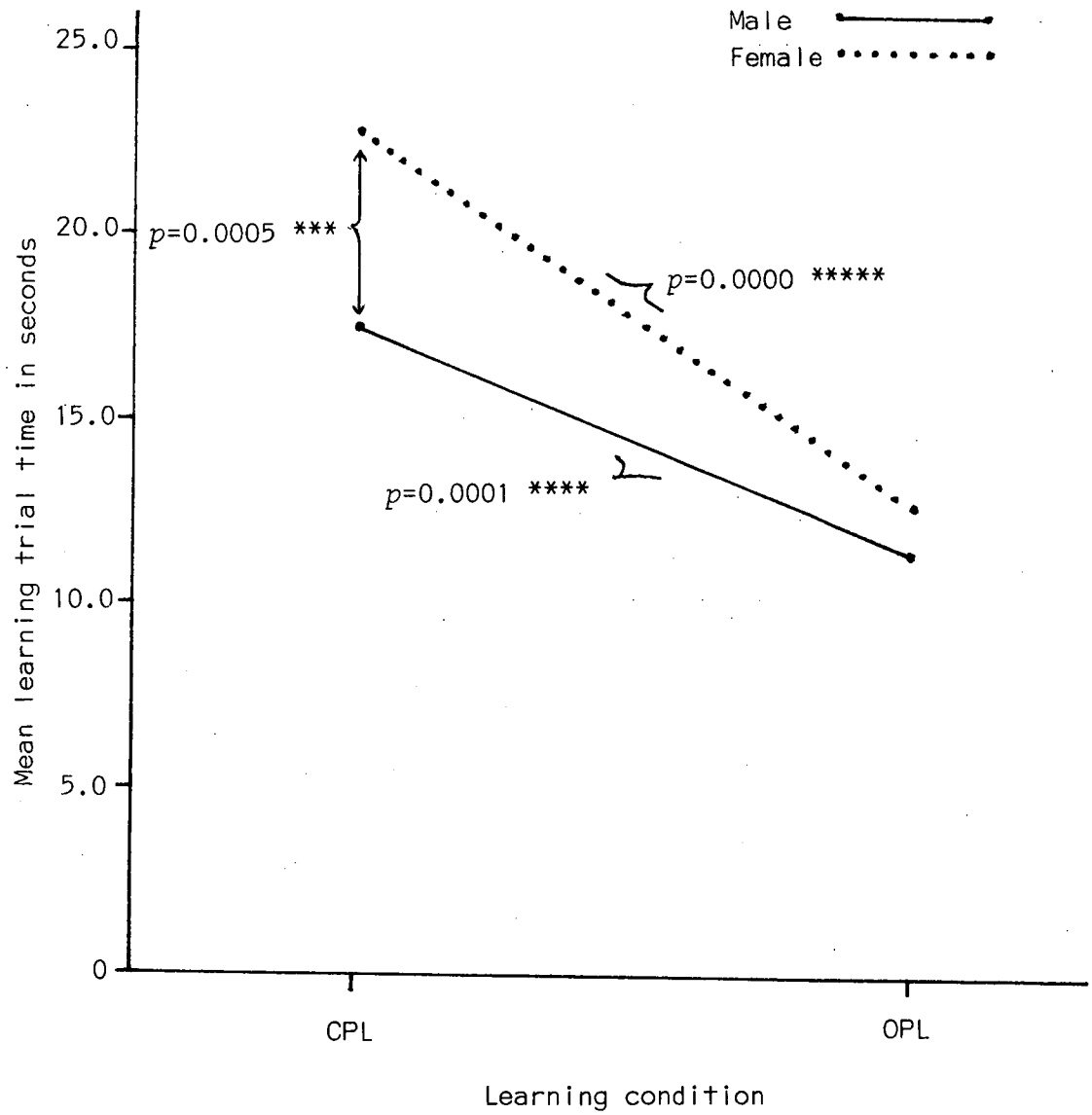

FIGURE 20 Mean learning trial time during the learning phases of Sessions 1 and 3

Table 5

2 x 2 analysis of variance for sex and learning condition

(mean trial time during total learning)

	SS	df	MS	F	P	
S	673.5873	1	673.5873	10.2185	0.0015	**
LC	3795.5714	1	3795.5714	57.5798	0.0000	****
S x LC	236.2539	1	236.2539	3.5840	0.0596	
Error	14897.5666	226	65.9184			
Total	19600.3304	229	85.5909			

greater than that of males. The *t* test results (see Figure 20) indicate however that, although the mean trial time for females was greater than for males irrespective of learning condition, it was the highly significant difference between CPL males and females (p=0.0005 ***) that brought about the significant main effect for sex and also the trend towards significant interaction between the main variables.

Results for the learning condition variable show that the mean trial time for CPL subjects, irrespective of sex, was significantly greater than that of their OPL counterparts (females, p=0.0001 ****; males, p=0.0000 ****).

Explanations for these results will be withheld until the discussion relating to mean trial time for <u>each</u> of the five learning trials has been presented. Table 6 contains the mean time (in seconds) taken by each cell group to complete each of these five trials. These results are depicted in Figure 21.

Table 6

Mean time (in seconds) taken to complete each of the five trials of the combined learning phases in sessions one and three

Cell	Trial				
	1	2	3	4	5
CPL Males	24.5	16.75	16.58	16.83	12.92
CPL Females	35.33	23.58	20.83	17.33	17.83
OPL Males	13.1	12.1	11.3	10.1	10.4
OPL Females	17.75	13.75	11.92	10.25	10.33

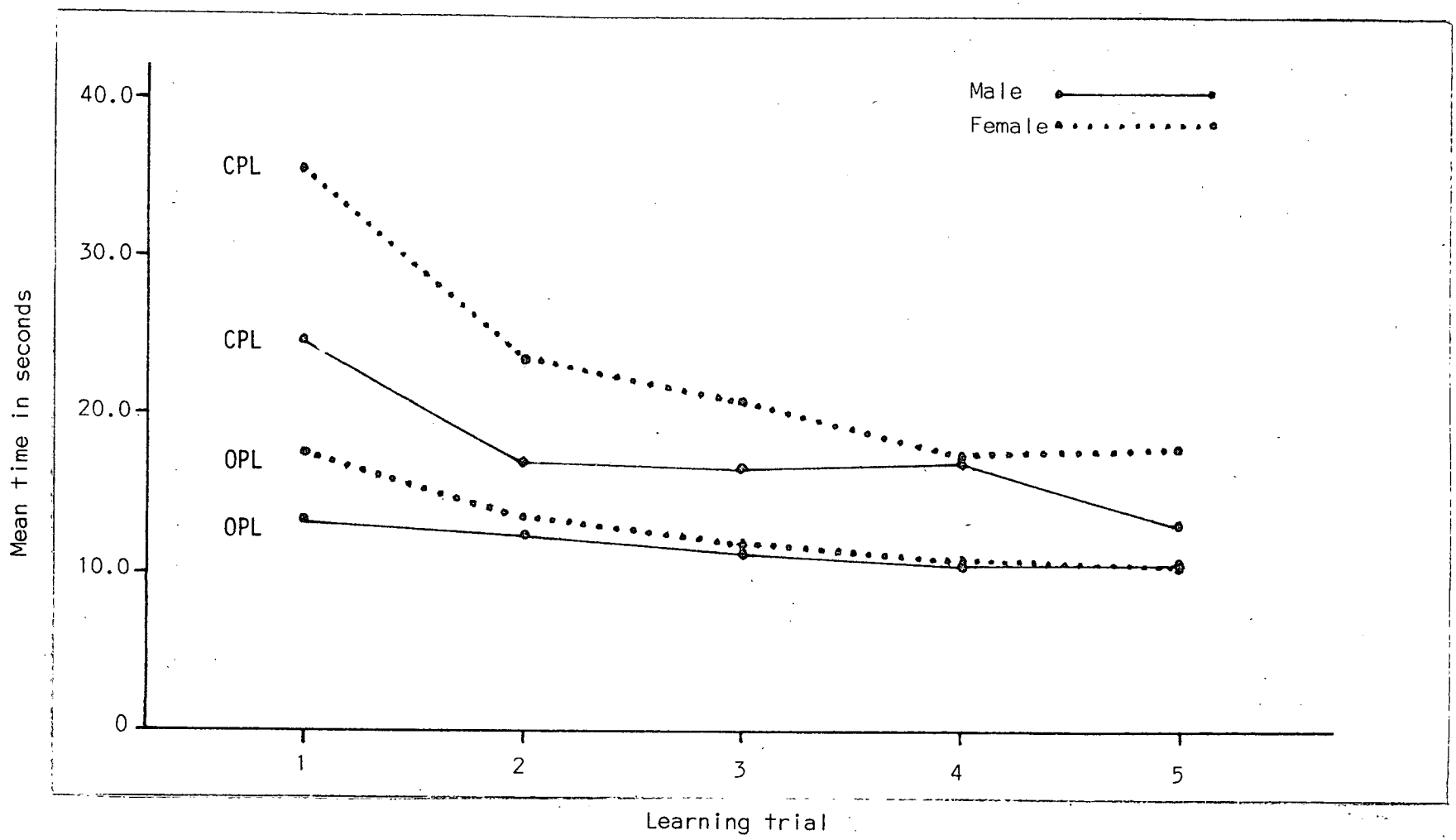

FIGURE 21 Mean time for each of the five learning trials

Following an examination of Figure 21 the following points can be made:

(i) CPL male and female groups both took consistently more time than their OPL counterparts to complete each trial. In the case of females this difference remained quite considerable throughout; whereas, the difference between male groups was notable only in trials one and four. From a comparison of mean number of errors and mean time for each of the five learning trials it is clear that errors made and time taken are closely related. This is quite an obvious explanation.

(ii) The patterns indicated by CPL male and female groups are similar in that both graph lines indicate an initial decrease in time followed by a plateau. It is interesting to note that mean time per trial decreased to a similar point (17.0 seconds approximately) before levelling in both cases. For CPL females, whose mean time for trial one (35.33 seconds) was considerably higher than that of CPL males (24.5 seconds), this decrease occurred over four trials; in males, over two trials. These patterns of CPL male and female groups differ in that, within the restrictions of only five trials being played, the male pattern showed a further decrease in time after the plateau. This decrease resulted in the mean time difference of trial five, between CPL males and OPL groups, being quite small. Furthermore, the

mean time of the fifth trial for CPL males was considerably lower than that of CPL females who remained on a plateau.

To some extent the findings of this second observation point can be explained similarly to the earlier point; namely, a correlation between errors made and time taken. The difference in mean time for the initial trial is intriguing and raises the question, "Why did CPL females take more time to complete Trial 1 than CPL males?" One obvious explanation is that the mean number of errors for trial one was higher for CPL females than males and such was the case. However, if one accepts this explanation another question promptly emerges: "Why the higher mean number of errors in trial one and consistently throughout other trials for CPL females than males?" One could hardly accept the explanation suggesting that CPL females may have found the manipulative skills required, more difficult than CPL males. This has previously been emphasized. It is interesting to note however, that both the error and time means for trial one indicated that females, irrespective of learning condition, took longer and made more errors than males. It appears that the most justifiable conclusion for these differences and particularly so for the time difference

between CPL males and females is that some factor (or combination of factors) which inhibited the female subjects' initial concentration and responding did not affect males similarly. Some such factors may have been anxiety, lack of curiosity, mental attitude towards an activity involving apparatus resembling male stereotyped toys and which did not involve auditory stimuli, and lack of social reinforcement or interaction during the learning process. Any one, or combination of, these possible factors may in some degree have contributed to these results. It is clearly seen from the similar patterns and levelling-off points for learning plateaus that CPL females and males underwent quite similar learning experiences. The one major exception has been pointed out and will be repeated for emphasis. Initially during the learning phase of the experiment females may not have been attending, or concentrating on, or as stimulated by the task to the degree that males were. Because of the short duration of the learning phase and the limit of five trials, the results relating to female learning (whether it be time, errors, or criterion responding) are thereby influenced negatively. It would be interesting to repeat this study with the modification of holding 6 or 7 learning trials instead of 5. The evidence presented in this study; namely, indications that CPL males and females followed similar learning patterns and the fact that there was no significant difference in criterion responding for CPL males and females during delayed

retention testing, suggests that such an increase learning trials may result in quite similar criterion responding results for CPL males and females. To conclude this point it should be mentioned that the results may be an artifact of an "odd" sample of females (despite random selection and allocation) due to the adequate but small sample of the study.

(iii) The mean trial times for OPL male and female groups remained consistently low throughout the learning phase (range: 17.75 to 10.1 seconds). The slight difference between the groups was clearly insignificant for all trials. This finding is consistent with previous observations that few errors were made by OPL subjects because of their attention to the physical linkage clue. This of course, reduced dramatically the number of matching responses to complete a learning trial and time taken was correspondingly reduced.

4.4 Summary of the results

The results of this study are summarized as follows:

(i) The covert physical linkage feedback conditions produced more effective learning of association responses by the sample of normal infant school children than overt physical linkage feedback conditions. This difference in learning was significant during immediate retention testing (p=0.0195 *) and highly significant during delayed retention testing (p=0.0060 **). Research

hypothesis 1 is therefore supported by the evidence in this study.

(ii) It was hypothesized that there would be no significant sex difference in the effective learning of association responses for both the CPL and the OPL feedback conditions. The results revealed no significant sex difference during both immediate retention testing (p=0.1162) and delayed retention testing (p=0.2601). However, a significant interaction effect (p=0.0382 *) between the main effects of learning condition and sex was evident for immediate retention testing only. Further analysis showed this effect to be the result of CPL females' learning being significantly lower than that of CPL males (p=0.0149 *) and furthermore, CPL females' learning being not significantly higher than that of OPL females. Several explanations were offered in view of the probes into errors occurring and time taken during each of the learning trials. These probes showed learning by CPL males and females to follow a quite similar pattern apart from an initial higher amount of error responding for females. Factors were discussed which may have interfered with the initial attention, concentration and stimulation of females which may not have similarly affected males. The trend of the results in this study is supportive of Hypothesis 2. Further investigations are needed however.

(iii) More errors occurred during the learning process with covert physical linkage feedback than with overt physical

linkage feedback. This difference was highly significant (0.0000 ****) in this study and supports strongly the quite predictable hypothesis three. The low number of error responses made under the OPL condition by both sexes indicates that the subjects attended to the irrelevant stimuli of the physical linkage clue. This result, viewed in conjunction with that of Hypothesis 1, reveals that this attention to task irrelevant stimuli (the physical linkage clue) interfered with attention to the critical stimuli to be learned.

4.5 Subjects' strategies for remembering

When discussing the role of memory in association learning during the survey of literature for this study, it was mentioned that all subjects who successfully acquired association responses to the novel stimuli would be questioned as to their strategies (if any) for remembering the association. This occurred at the conclusion of the experimental sessions. The question was asked, *Did you have any little tricks or things you thought of that helped you remember which creatures and names belonged together?* Figure 22 illustrates the number of criterion responses to each novel stimulus pair during immediate retention and/or delayed retention testing.

From this graph it is clearly seen that the 'hov' was the least effectively learned association. The only criterion response to it was by one subject during initial testing. The association was not retained for 24 hours. It is suggested that the word 'hov' may have caused acoustical interference in short-term memory because of its similarity to the familiar abstract word 'have'. Subjects may have

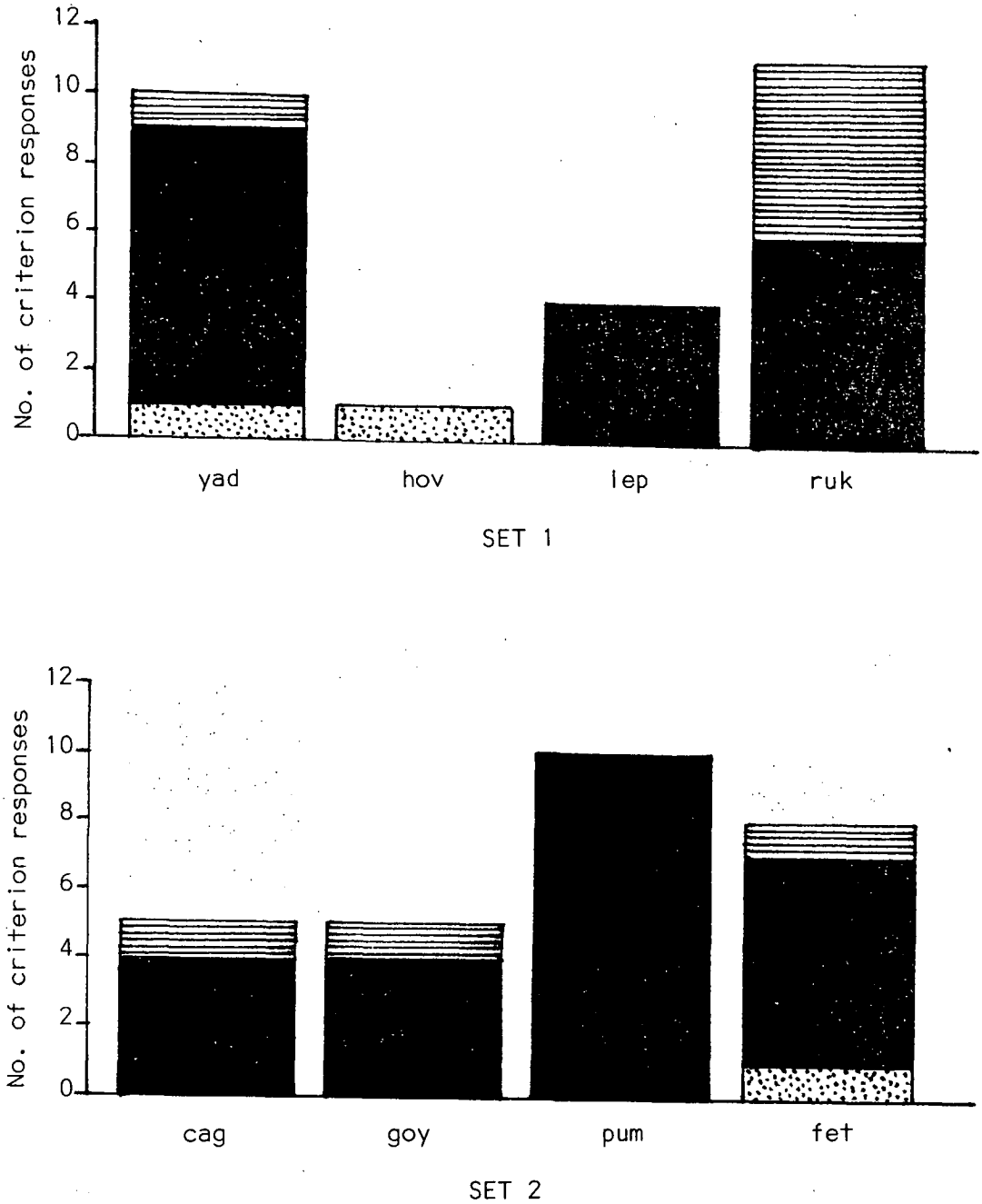

FIGURE 22 No. of criterion responses to each stimulus pair during immediate retention testing (IRT) and/or during delayed retention testing (DRT)

criterion responses occurring during IRT only

criterion responses occurring during both IRT and DRT

criterion responses occurring during DRT only

found it difficult to associate a creature with such a word. The response to 'pum' on the other hand, was comparatively high and the subjects' replies relating to their remembering strategies indicated why this was so. *Pum is like a bump,* stated one subject. *Pum looks like an animal,* stated another. It appeared that memory was aided by acoustic and visual facilitation in these instances.

The replies of subjects indicated that they had used mnemonic strategies or associative codes for remembering the associations. In by far the majority of instances, these strategies had effectively assisted learning. A few instances revealed however that an incorrect association had been embedded because of a weak strategy resulting from visual and/or acoustic interference. For example, the consistently incorrect responding of one subject in associating the creature 'lep' with the word 'yad' was explained in her strategy, *Lep looks like a little pig who lives in a yard* [yad], A further example is that of a subject who consistently and incorrectly matched the creature 'cag' with the word 'goy'. His strategy was; *He looks happy. He's got his legs all out, so he goes with goy* [joy]. It was obvious in both these instances that perhaps visual as well as acoustic interference had resulted in the confusions between 'yad/yard' and 'goy/joy'. The individual environmental backgrounds also obviously affected the learning strategies of the children as they tried to associate and relate the strange novel stimuli to their existing associations. One subject responded, *I know the name of the bird but I don't know the others. It's a yad.* Another responded, *Yad? He goes in a yard* [yad].

One subject who acquired six out of the possible eight association responses had strategies for all stimuli, one strategy

in each stimulus set being, *It was left over*, and *I just remembered that one*. This strategy worked effectively as he always left those associations till last.

It was difficult to know whether or not some subjects relied solely on a visual memory picture of the association or whether they were simply unable (or were too shy) to describe their strategy if having one. Several responded, *I just remembered*, or *I just knewed*. Additional successful strategies that subjects used were as follows:

In response to creature 'fet' which had two legs and two feet; *He's walking with his feet.*

In response to creature 'cag', a round shape containing a semi-circular stripe; *Looks like he's in a cage.*

In response to 'ruk', a broad shape with flippers; *It's like a rug with flippers.*

In response to 'hov', a long, thin, fish-like creature; *He's high!*

It was significant to note that in only two instances were strategies reportedly used by OPL subjects. Both of these instances involved the creature 'yad'.

CHAPTER 5

IMPLICATIONS FOR THE CLASSROOM

and

SUGGESTIONS FOR FURTHER RESEARCH

CHAPTER 5

IMPLICATIONS FOR THE CLASSROOM AND SUGGESTIONS FOR FURTHER RESEARCH

The findings of this study may have limited applicability due to several factors. Firstly, the sample, although adequate, was small and representative of the normal seven year-olds attending only one middle class socio-economic school. Secondly, although limited social interaction took place throughout the experiment and the prepared set of verbal directions was adhered to closely, any interaction effect that may have existed between the sex of the experimenter and the sex of the subjects was not controlled in the study's design. A female conducted the experimental sessions with all subjects. A further limitation is the study's investigation of only one type of overt clue (a physical linkage clue) in the built-in feedback signalling device of auto-instructional aids.

Although the number of subjects in this study was small, the highly significant differences call for a comment as to their implications for classroom practice.

5.1 Implications for the classroom

1. Some evidence (Garai & Scheinfeld, 1968; Hedges, 1978) and the subjective observations by many teachers suggest that males outnumber females in reading problems. The results of this study imply that young males are able to acquire association responses as effectively as females and perhaps more rapidly, given a set of learning conditions that

stimulate high levels of attention and concentration.

The results of this study have also indicated that in some circumstances males acquired association "reading" type responses more successfully than the females. Such a result, if replicated, would have important implications for special education and the acquisition of reading responses. The manual and manipulative co-ordinates of this learning problem together with the control of irrelevant stimuli allowed the males to focus on the relevant stimuli and created a situation where they were keen and curious to solve the problem. Such a procedure may form the basis of a preventative measure of reading failure.

2. Cohen, Alberto, and Troutman (1979) point out that attention to sound teaching principles when selecting and/or developing educational materials will help prevent wasteful use of instructional time. This study indicates that very little attention is given to the critical stimuli to be learned in an association matching task having physical linkage clues present as to which stimuli should be associated. Both male and female subjects attended to the irrelevant stimuli. This certainly allowed them to complete the learning task rapidly but it prevented them from learning the task. Examples illustrating the necessity for critical reading and care in developing or selecting instructional aids have been noted in the literature. One such example is that by Mercer and Mercer (1978) who describe several methods teachers may use to make materials self-correcting. Puzzles containing physical linkage cueing is one such method. The Flip Sider Method

(see Figure 23) is also recommended by the writers. This method requires that the reverse sides of matching cards contain an obvious match such as picture completion, an equal number of dots, or texture match. It is clearly possible (and quite probable) for a child to use the feedback device of these materials as cues. With puzzles, attention may be diverted from the stimuli to be learned to the irrelevant cueing stimulus. Similarly with Flip Siders, even in the event of a child not using the reverse sides as clues when initially responding, eventually it is necessary for the cards to be reversed to gain feedback. At this feedback stage the stimuli to be learned are not visible to him. Instead, an irrelevant matching on the reverse side demands attention.

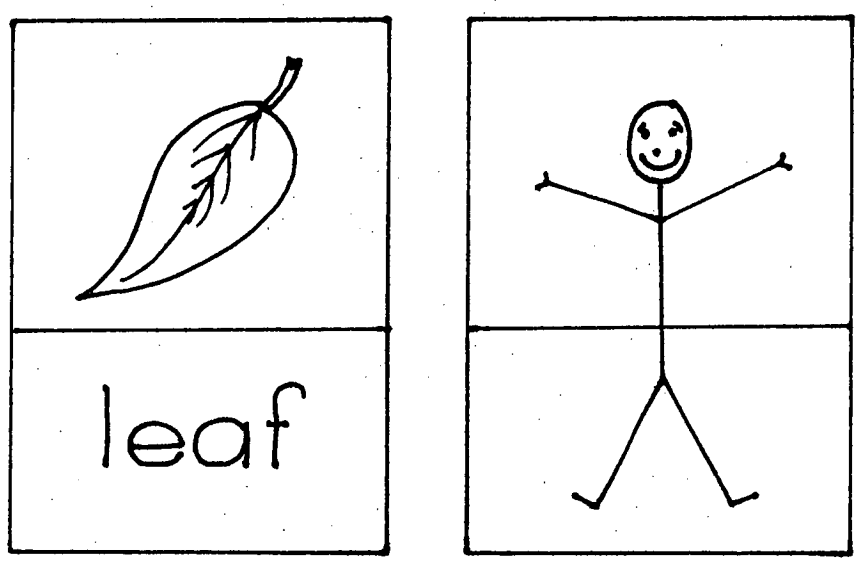

FIGURE 23 Flip Sider matching cards

It will be recalled that Jackson (1975) noted a trend for

even a relevant matching feedback object to detract from the significance of the word (the unknown stimulus) in an association matching task and thereby affect learning negatively. Underwood (1976) has stated; "Unless we are able to attend exclusively to one object or one task, at the expense of other objects and tasks, the performance will suffer" (p.210). It appears from this present study that the use of auto-instructional aids containing overt physical linkage clues virtually determines that the learner will not attend exclusively to the relevant task and as the results show, learning suffers.

3. It was not the purpose of this study to discuss the advantages or disadvantages to exceptional children of integration with normal school children, or the practical feasibility of such practice (Esposito, 1973; Haring & Krug, 1975; Lunn, 1975; Sheare, 1974; Siegel, 1969; Snyder, Apolloni, & Cooke, 1977). However, it is noted that much of the success or failure related to integration is directly attributed to the individual teacher and the programs developed by him to meet the needs of each child. Sound individualized instructional procedures and aids are clearly essential firstly, for the prevention of problem-causing conditions amongst all children and secondly, if the integration of exceptional children into normal schools is to become an effective practice.

The limitations of this study and its intriguing results provoke the following suggestions for future research.

5.2 Suggestions for future research

(i) Replication of the study with

(a) larger and more representative samples;

(b) younger children who have acquired no reading responses;

(c) exceptional children such as the deaf and mildly mentally retarded.

(ii) As for suggestion (i) but with built-in control for any interaction effect between the sex of the experimenter and the sex of the subjects.

(iii) Investigations of overt colour clues and overt continuous line clues on basically similar apparatus to that used in this study.

(iv) As mentioned in the results chapter, replication of the study but with increased learning trials (greater than five) is needed.

(v) Comparison of association response acquisition under the conditions of a CPL self-correcting auto-instructional aid, and a typical word/picture matching activity such as that conducted in an infant classroom where the aids contain no built-in feedback and the learner receives delayed verbal feedback at the conclusion of the exercise.

To conclude this section, the following statement by Haring and Schiefelbush (1976) seems pertinent:

"If educators must assume responsibility for the results of

instruction, they must show the variable effects of different modes of instruction. Only in this way can the variable instructional effects be determined and improvements in instruction be highlighted" (p.5).

REFERENCES

REFERENCES

Allen, S.A., Spear, P.S., & Lucke, J.R. Effects of social reinforcement on learning and retention in children. Developmental Psychology, 1971, 5, 73-80.

Annett, J. Feedback and human behaviour. Middlesex, England: Penguin Books, 1969.

Atkinson, R.C., & Shiffrin, R.M. Human memory: A proposed system and its control processes. In Spence, K.W. & Spence, J.T. (Eds.) The psychology of learning and motivation: Advances in research and theory. Vol. 2. New York: Academic Press, 1968.

Baumrind, D., & Black, A.E. Socialization practices associated with dimensions of competence in preschool boys and girls. Child Development, 1967, 38, 291-327.

Berko, J. In Saporta, S. (Ed.) Psycholinguistics. New York: Holt, Rinehart & Winston, 1961.

Berko, J. The child's learning of English morphology. Word. 1958, 14, 150-177.

Campbell, D.T., & Stanley, J.C. Experimental and quasi-experimental designs for research. Chicago: Rand McNally, 1966.

Cleary, A., Mayes, T. & Packham, D. Educational technology: Implications for early and special education. London: John Wiley & Sons, 1976.

Cohen, S.B., Alberto, P.A., & Troutman, A. Selecting and developing educational materials: An inquiry model. Teaching Exceptional Children, 1979, 12(1), 7-11.

Conrad, R. Acoustic confusions in immediate memory. British Journal of Psychology, 1964, 55, 75-84.

Craik, F.I.M., & Lockhart, R.S. Levels of processing: A frameword for memory research. Journal of Verbal Learning and Verbal Behaviour, 1972, 11, 671-684.

Craik, F.I.M., & Watkins, M.J. The role of rehearsal in short-term memory. Journal of Verbal Learning and Verbal Behaviour, 1973, 12, 598-607.

Daehler, M.W. Children's manipulation of illusory and ambiguous stimuli, discriminative performance and implications for conceptual development. Child Development, 1970, 41, 225-241.

Darwin, C.J., Turvey, M.T., & Crowder, R.G. An auditory analogue of the Sperling partial report procedure: Evidence for brief and auditory storage. Cognitive Psychology, 1972, 3, 255-267.

DeCecco, J.P., & Crawford, W.R. The psychology of learning and instruction. (2nd ed.) Englewood Cliffs, New Jersey: Prentice-Hall, 1974.

Douglas, J.D., & Rice, K.M. Sex differences in children's anxiety and defensiveness measures. Developmental Psychology, 1979, 15, 223-224.

Esposito, D. Homogeneous and heterogeneous ability grouping: Principal findings and implications for evaluating and designing more effective educational environments. Review of Educational Research, 1973, 43(2), 163-179.

Farrell, M. Sex differences in block play in early childhood education. Journal of Educational Research, 1957, 51, 279-284.

Fine, B. Teaching machines. London: Oak Tree Press, 1963.

Fontana, D., & Evans, H. Mode of stimulus presentation and short-term memory efficiency in primary school children. British Journal of Educational Psychology, 1980, 50, 229-235.

Garai, J.E., & Scheinfeld, A. Sex differences in mental and behavioural traits. Genetic Psychology Monographs, 1968, 77, 169-299.

Glanzer, M. Storage mechanisms in recall. In Bower, G.H. (Ed.) The psychology of learning and motivation. New York: Academic Press, 1972.

Glaser, R. Individuals and learning: the new aptitudes. Educational Researcher, 1972, 1(6), 5-13. Cited in Maccoby, E.E., & Jacklin, C.N. The psychology of sex differences. London: Oxford University Press, 1975.

Guthrie, J.T., & Goldberg, H.K. Visual sequential memory in reading disability. Journal of Learning Disabilities, 1972, 5, 41-46.

Haring, N.G., & Krug, D.A. Placement in regular programs: Procedures and results. Exceptional Children, 1975, 413-417.

Haring, N.G., & Schiefelbusch, R.L. Teaching special children. New York: McGraw-Hill, 1976.

Hedges, W.D. At what age should children enter first grade: A comprehensive review of the research. University Microfilms International, Ann Arbor, Michigan, 1977.

Hellyer, S. Frequency of stimulus presentation and short-term decrement in recall. Journal of Experimental Psychology, 1962, 64, 650.

Honzik, M.P. Sex differences in the occurrence of materials in the play constructions of preadolescents. Child Development, 1951, 22, 15-35.

Jackson, M.S. An investigation of word object association behaviour in trainable mentally retarded children. Unpublished doctoral thesis, Monash University, Melbourne, 1972.

Jackson, M.S. Reading disability; Experiment, innovation, and individual therapy. Sydney: Angus & Robertson, 1972(a).

Jackson, M.S. Visual feedback in word acquisition behaviour in moderately retarded subjects. The Slow Learning Child, 1974, 21, 155-163.

Jackson, M.S. The learning association module: A technique for the disabled reader. How to teach your child to read. Hobart: University of Tasmania, 1976.

Jackson, M.S. Crisis in reading: Therapeutic intervention management techniques. Australian International Press, 1977.

Jackson, M.S. Manipulating visual feedback in word acquisition behaviour in TMR subjects. Journal of Special Education, 1977, 11, 73-79(a).

Jersild, A.T., & Holmes, F.B. Children's fears. Child Development Monographs, 1935, 20.

*

Lindsay, P.H., & Norman, D.A. Human information processing: An introduction to psychology. New York: Academic Press, 1972.

Loftus, G.R., & Loftus, E.F. Human memory. The processing of information. New Jersey: Lawrence Erlbaum Associates, 1976.

Lunn, J.C.B. Streaming in the primary school - Streaming research project. N.F.E.R., London, 1970.

Lunzer, E.A., Dolan, T., & Wilkinson, J.E. The effectiveness of measures of operativity, language and short-term memory in the prediction of reading and mathematical understanding. British Journal of Educational Psychology, 1976, 46, 295-305.

Maccoby, E.E., & Jacklin, C.N. The psychology of sex differences. London: Oxford University Press, 1975.

Mercer, C.D., & Mercer, A.R. The development and use of self correcting materials with exceptional children. Teaching Exceptional Children, 1978, 11(1), 6-11.

Millar, R.B. Handbook of training and equipment design. WADC Technical Report, 1953, 53-136. Cited in Annett, J., Feedback and human behavior, Middlesex, England: Penguin, 1969.

Miller, G.A. The magical number seven, plus or minus two: Some limits on our capacity to process information. Psychological Review, 1956, 63, 81-97.

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* Keppel, G. Design and analysis. A researcher's handbook. (2nd ed.) Englewood Cliffs, N.J.: Prentice-Hall, 1982.

Montessori, M. The Montessori method. Massachusetts: Robert Bentley, 1965.

Morton, J., Crowder, R.G., & Prussin, H.A. Experiments with the stimulus suffix effect. Journal of Experimental Psychology Monographs, 1971, 91, 169-190.

Neisser, U. Cognitive psychology. New York: Appleton-Century- Crofts, 1967.

Pollack, I. The assimilation of sequentially coded information. American Journal of Psychology, 1953, 66, 421-435.

Pulaski, M. Play as a function of toy structure and fantasy predisposition. Child Development, 1970, 41, 531-537.

Rosner, J.A. The development and validation of an individualized perceptual skills curriculum. University of Pittsburgh, Learning Research & Development Center, 1973.

Sheare, J.B. Social acceptance of E.M.R. adolescents in integrated programs. American Journal of Mental Deficiency, 1974, 78, 678-682.

Sherman, J.A. Sex-related cognitive differences. Springfield, Illinois: Charles C. Thomas, 1978.

Siegel, E. Special education in the regular classroom. New York: John Day, 1969.

Skinner, B.F. Science and human behavior. New York: MacMillan, 1953.

Skinner, B.F. Teaching machines. Science, 1958, 128, 969-977.

Smith, D.J.H. A comparison between the efficacy of word and picture feedback in the association learning of normal four and a half year old children. Unpublished micro-research, Monash University, 1974. Cited in Smith, D.J.H., An empirical investigation of the efficacy of task-specific versus task-related feedback in the word-acquisition behaviour of a sample of normal pre-school

children. Unpublished master's thesis, Monash University, Melbourne, 1975.

Smith, D,J,H, An empirical investigation of the efficacy of task-specific versus task-related feedback in the word-acquisition behaviour of a sample of normal pre-school children. Unpublished master's thesis, Monash University, Melbourne, 1975.

Smith, R.M., & Neisworth, J.T. The exceptional child. A functional approach. New York: McGraw-Hill, 1975.

Snyder, L., Apolloni, T., & Cooke, T.P. Integrated settings at the early childhood level: The role of nonretarded peers. Exceptional Children, 1977, 43, 262-266.

Spence, J.T. Verbal and nonverbal rewards and punishments in the discrimination learning of children of varying socio-economic status. Developmental Psychology, 1972, 6, 381-384.

Sperling, G. The information available in brief visual presentations. Psychological Monographs, 1960, 74, (whole no. 498).

Stroop, J.R. Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 1935, 18, 643-662.

Tobias, S. Anxiety research in educational psychology. Journal of Educational Psychology, 1979, 71, 573-582.

Underwood, G. Attention and memory. New York, Pergamon Press, 1976.

Ward, W.D. Variance of sex-role preference among boys and girls. Psychological Reports, 1968, 23, 467-470.

Watson, J.S. Operant conditioning of visual fixation in infants under visual and auditory reinforcement. Developmental Psychology, 1969, 1, 508-516.

Wickelgren, W.A. Acoustic similarity and intrusion errors in short-term memory. Journal of Experimental Psychology, 1965, 70, 102-108.

Wine, J. Test anxiety and direction of attention. Psychological Bulletin, 1971. 76, 92-104.

Yando, R.M., Zigler, W., & Gates, M. The influence of Negro and white teachers rated as effective or noneffective on the performance of Negro and white lower-class children. Developmental Psychology, 1971, 5, 290-299.

APPENDICES

APPENDIX I

The Sample

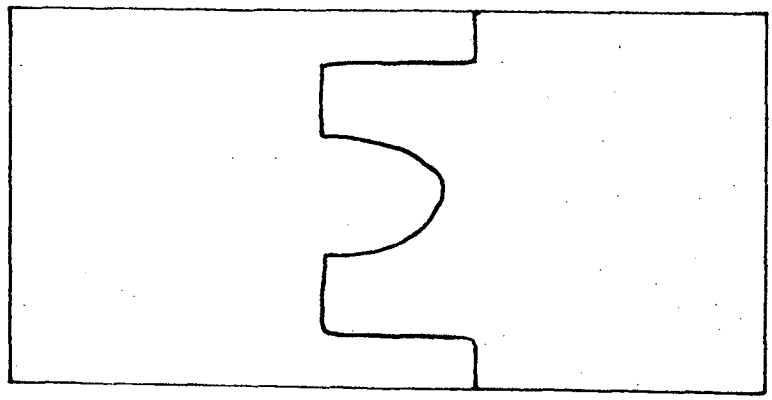
LEARNING CONDITION

CPL				OPL			
Subject Exp.no.	Sex	Name	C.A. yrs mths	Subject Exp.no.	Sex	Name	C.A. yrs mths
1	M	Andrew	7 - 3	13	M	Darren	7 - 4
2	M	Gavin	7 - 2	14	M	Brett	7 - 0
3	M	Eric	7 - 3	15	M	Scott	7 - 3
4	M	Andrew	7 - 1	16	M	Brendon	7 - 1
5	M	Tasman	7 - 2	17	M	Anthony	7 - 4
6	M	Andrew	7 - 1	*18	M	Zane	7 - 1
7	F	Melissa	7 - 3	19	F	Sharee	7 - 3
8	F	Penny	7 - 2	20	F	Meegan	7 - 2
9	F	Isabella	7 - 4	21	F	Jodie	7 - 3
10	F	Jacqueline	7 - 3	22	F	Anita	7 - 3
11	F	Annette	7 - 0	23	F	Joanne	7 - 0
12	F	Natasha	7 - 0	24	F	Nikki	7 - 3
		($\bar{X}$ C.A. males	7 - 2)			($\bar{X}$ C.A. males	7 - $2\frac{1}{6}$)
		($\bar{X}$ C.A. females	7 - 2)			($\bar{X}$ C.A. females	7 - $2\frac{1}{3}$)
		$\bar{X}$ C.A. C.P.L.	7 - 2			$\bar{X}$ C.A. O.P.L.	7 - $2\frac{1}{4}$

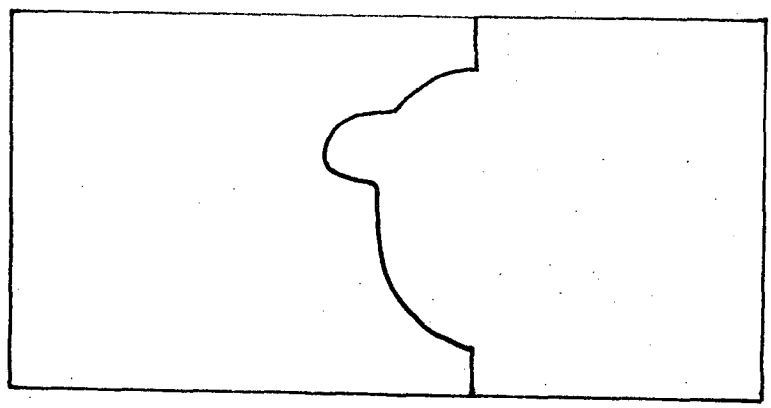
* withdrew from experiment because of sickness

APPENDIX II

The 10 Variations in Interlocking Combination used in the study



Variation 1



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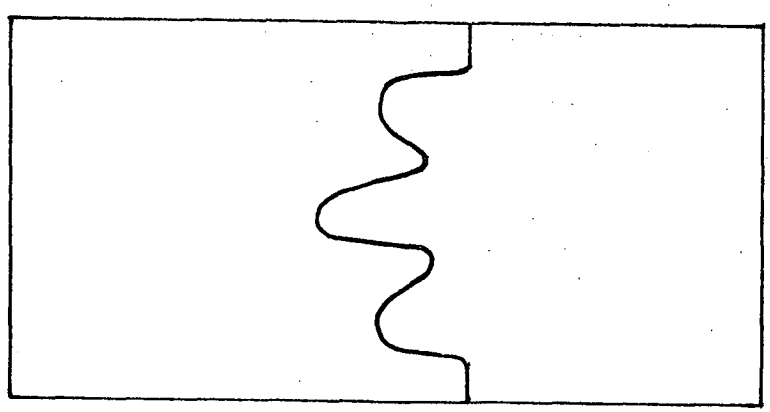

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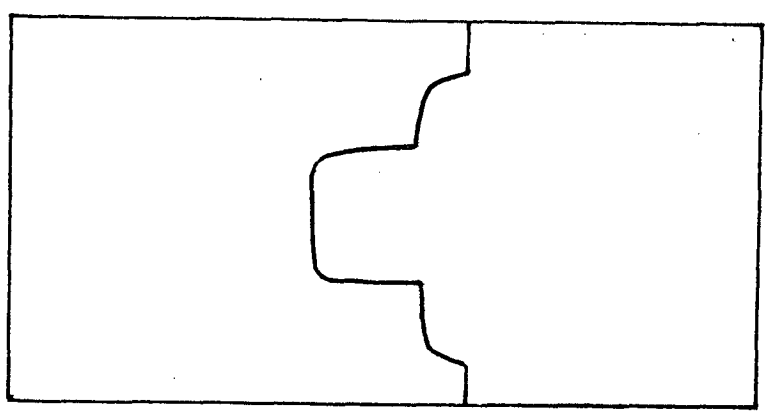

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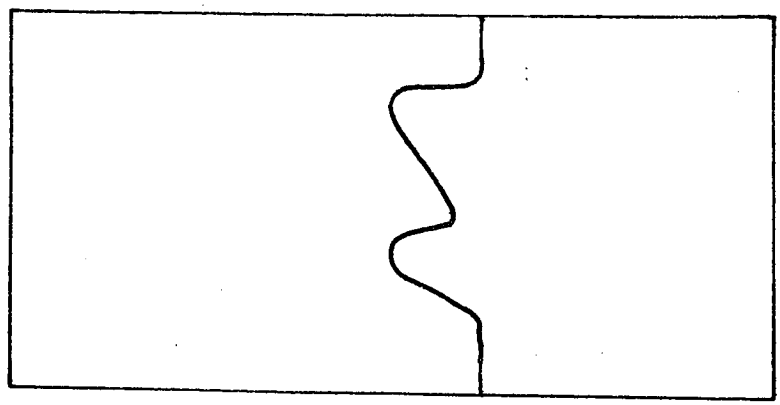
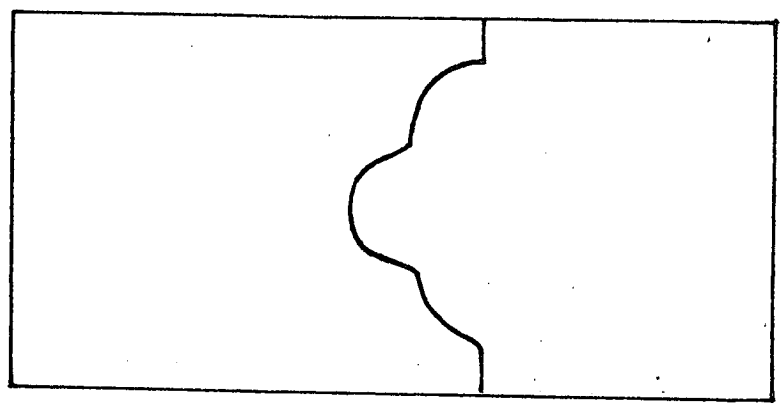


Variation 5´



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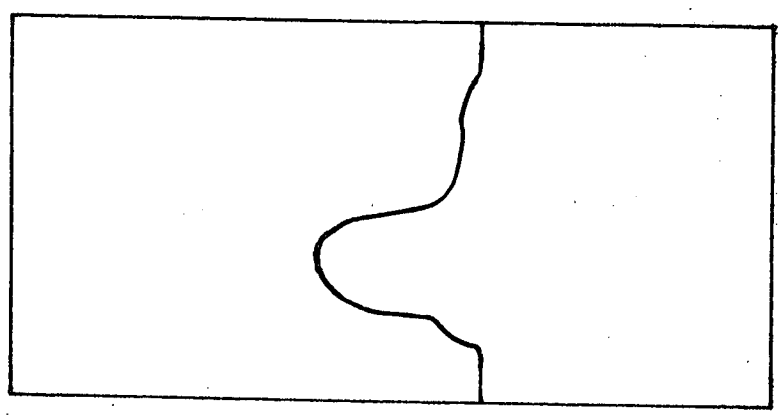

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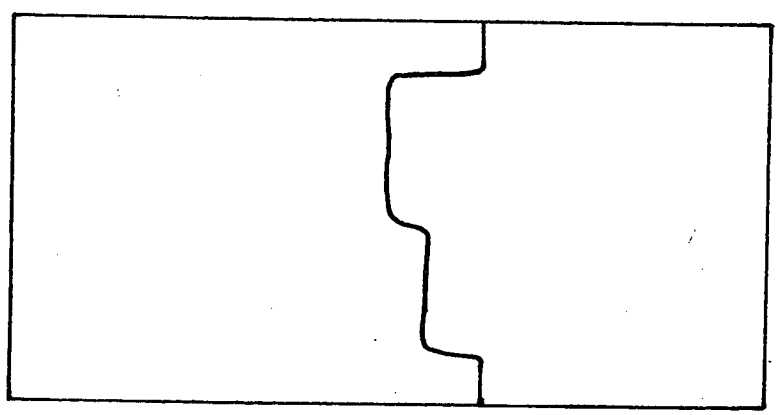

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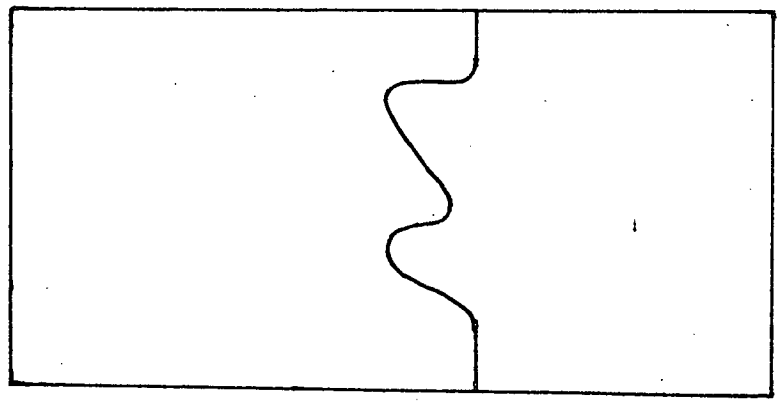
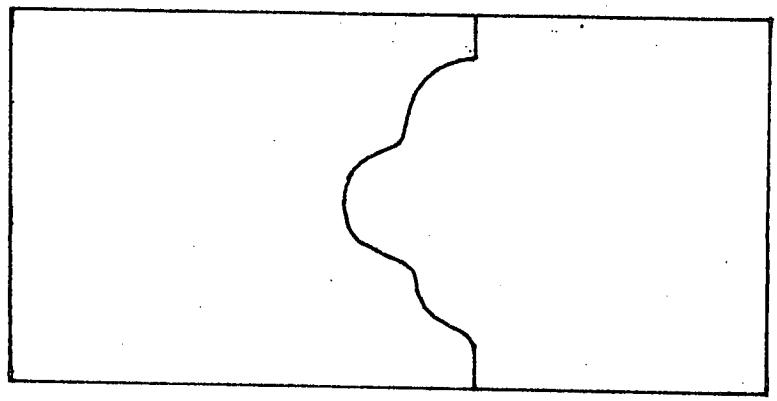


Variation

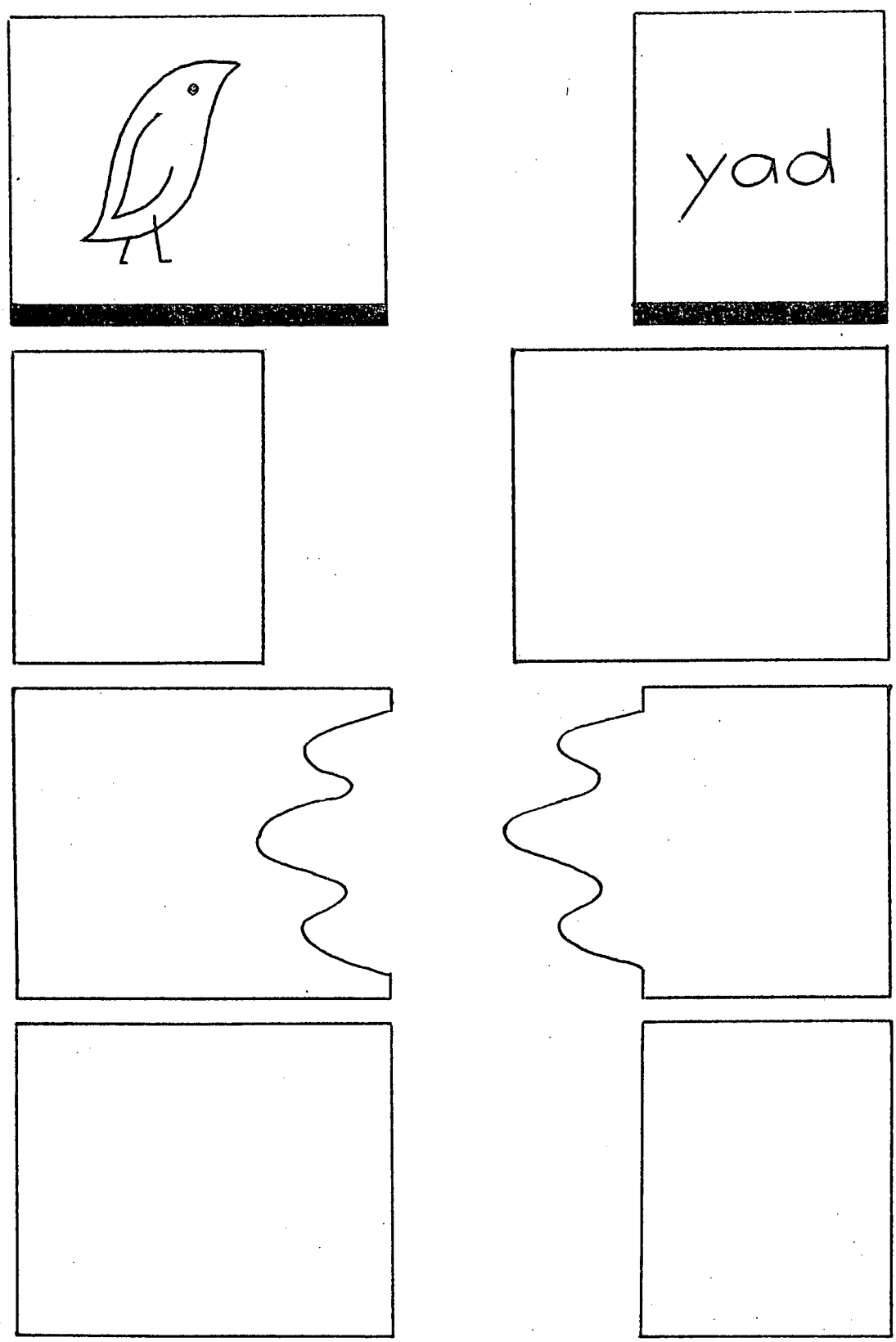
9



10

APPENDIX III

Example Illustrating the Design and Assembly of CPL Apparatus*

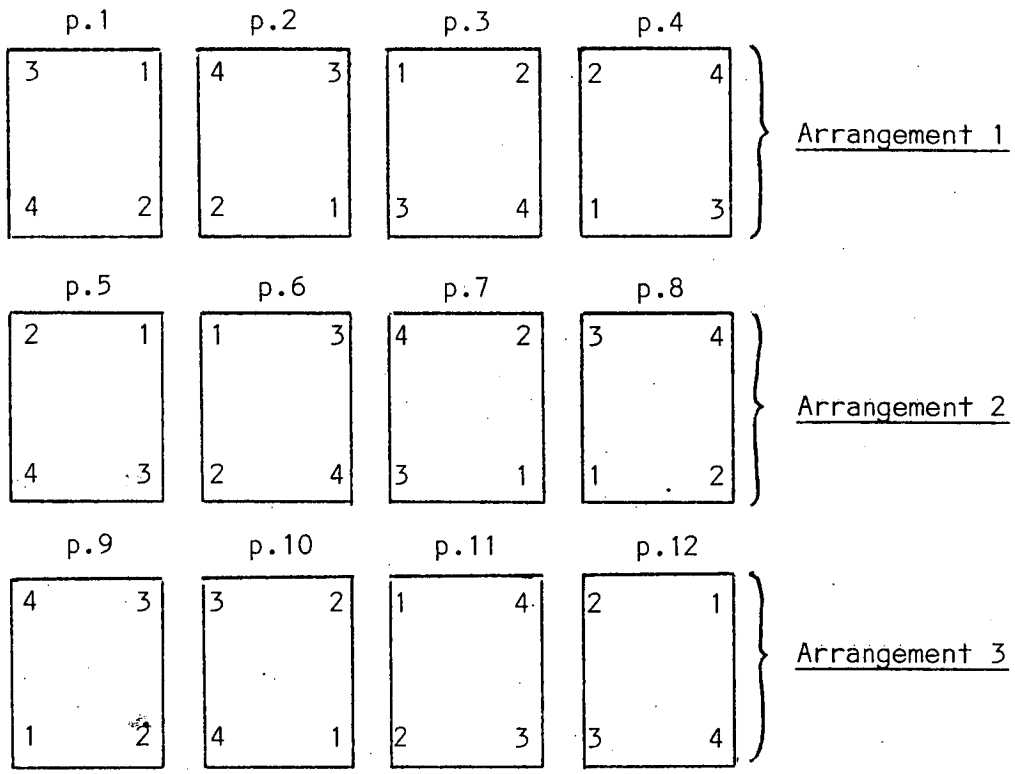


* The 4 layers are illustrated in the same order from top to bottom as that in which they were glued together.

APPENDIX IV

Random Order Followed in Displaying

Word Stimuli in Test Booklets (Sets 1 and 2)



APPENDIX Va

Data Recording Sheet (Set 1)

EXP. NO. _____ NAME: _____ IQ: _____ C.A._____ SEX: _____

SCHOOL: _____ DATE: _____ TIME: _____ LEARNING CONDITION: _____ SET 1

LEARNING (Record each word stimulus response by recording X (error) or ✓(correct).)

PICTURE STIMULI	TEST CARDS					TEST BOOKLET					
	1	2	3	4	5	1	2	3	4	5	TOTAL
 (yad)											
 (hov)											
 (lep)											
 (ruk)											
TIME											

IMMEDIATE RETENTION TESTING

PICTURE STIMULI	TEST CARDS							TEST BOOKLET						
	TRIAL			CORRECT RESP.				TRIAL			CORRECT RESP.			
	1	2	3	1	2	3	TOTAL	1	2	3	1	2	3	TOTAL
 (yad)														
 (hov)														
 (lep)														
 (ruk)														

DELAYED RETENTION TESTING

PICTURE STIMULI	TEST CARDS							TEST BOOKLET						
	TRIAL			CORRECT RESP.				TRIAL			CORRECT RESP.			
	1	2	3	1	2	3	TOTAL	1	2	3	1	2	3	TOTAL
 (yad)														
 (hov)														
 (lep)														
 (ruk)														

APPENDIX Vb

Data Recording Sheet (Set 2)

EXP. NO. _____ NAME: _____ IQ: _____ C.A. _____ SEX: _____

SCHOOL: _____ DATE: _____ TIME: _____ LEARNING CONDITION: _____ SET 2

LEARNING (Record each word stimulus response by recording X (error) or ✓ (correct).)

PICTURE STIMULI	LEARNING TRIALS					ERROR RESPONSES					
	1	2	3	4	5	1	2	3	4	5	TOTAL
 (cag)											
 (goy)											
 (pum)											
 (fet)											
TIME											

IMMEDIATE RETENTION TESTING (Record each word stimulus response by writing the word response.)

PICTURE STIMULI	TEST CARDS							TEST BOOKLET						
	TRIAL			CORRECT RESP.				TRIAL			CORRECT RESP.			
	1	2	3	1	2	3	TOTAL	1	2	3	1	2	3	TOTAL
 (cag)														
 (goy)														
 (pum)														
 (fet)														

DELAYED RETENTION TESTING (Record each word stimulus response by writing the word response.)

PICTURE STIMULI	TEST CARDS							TEST BOOKLET						
	TRIAL			CORRECT RESP.				TRIAL			CORRECT RESP.			
	1	2	3	1	2	3	TOTAL	1	2	3	1	2	3	TOTAL
 (cag)														
 (goy)														
 (pum)														
 (fet)														

APPENDIX VI

Subjects' Order of Participation and Stimulus Set (12 or 21)

Participation Order	Exp. No. of S.	Learning Condition	Sex	Stimulus Set Order
1st	1	CPL	M	12
2	13	OPL	M	12
3	7	CPL	F	12
4	19	OPL	F	12
5	8	CPL	F	12
6	20	OPL	F	12
7	2	CPL	M	21
8	14	OPL	M	21
9	9	CPL	F	21
10	21	OPL	F	21
11	10	CPL	F	21
12	22	OPL	F	21
13	3	CPL	M	12
14	15	OPL	M	12
15	4	CPL	M	12
16	16	OPL	M	12
17	5	CPL	M	21
18	17	OPL	M	21
19	6	CPL	M	21
20	* 18	OPL	M	21
21	11	CPL	F	21
22	23	OPL	F	21
23	12	CPL	F	12
24	24	OPL	F	12

* withdrew from experiment because of sickness

APPENDIX VII

The Novel Stimuli Displayed on the

Variations of Interlocking Combinations

Interlocking combination Variation no. (see Appendix)	Novel stimuli displayed on both CPL and OPL apparatus
1	ruk
2	lep
3	yad
4	hov
	SET 1
5	cag
6	goy
7	fet
8	pum
	SET 2
9	* banana
10	* apple

* (Familiarization equipment only)

APPENDIX VIIIa

Raw Data Relating to the No. of 3 Consecutively Errorless Association Responses by CPL Males to any ONE Stimulus Pair During Testing

S	Stimuli	Immediate Retention Testing			Delayed Retention Testing			Total No. of 12 Correct Responses
		Test Cards	Test Bk	No. of 6 Correct Responses	Test Cards	Test Bk	No. of 6 Correct Responses	
1	yad (y) hov (h) lep (l) ruk (r) cag (c) goy (g) pum (p) fet (f)	l* r c	l r c g	3	l r c g	l r c g	4	3
2	y h l r c g p f	y h l r p f	y h l r p f	6	y h l r p f	y l r p f	5	5
3	y h l r c g p f	h c g p f	c g p f	4	y r c g p f	y l r c g p f	6	4
4	y h l r c g p f			-			-	-
5	y h l r c g p f	p	p	1	p	p f	1	1
6	y h l r c g p f	y p	y p	2	y r g p	l r p	2	1

* An initial letter represents 3 consecutively errorless responses to that stimulus pair.

APPENDIX VIIIb

Raw Data Relating to the No. of 3 Consecutively Errorless Association Responses by CPL Females to any ONE Stimulus Pair During Testing

S	Stimuli	Immediate Retention Testing			Delayed Retention Testing			Total No. of 12 Correct Responses
		Test Cards	Test Bk	No. of 6 Correct Responses	Test Cards	Test Bk	No. of 6 Correct Responses	
7	yad (y) hov (h) lep (l) ruk (r) cag (c) goy (g) pum (p) fet (f)	y f	y p	1	y c 	y c 	2	1
8	y h l r c g p f			-			-	-
9	y h l r c g p f	 g	 g	1	 r g	h r g	2	1
10	y h l r c g p f			-	r	r	1	-
11	y h l r c g p f	 r p f	 p f	2	l r p f	 r p f	3	2
12	y h l r c g p f			-			-	-

APPENDIX VIIIc

Raw Data Relating to the No. of 3 Consecutively Errorless Association Responses by OPL Males to any ONE Stimulus Pair During Testing

S	Stimuli	Immediate Retention Testing			Delayed Retention Testing			Total No. of 12 Correct Responses
		Test Cards	Test Bk	No. of 6 Correct Responses	Test Cards	Test Bk	No. of 6 Correct Responses	
13	yad (y) hov (h) lep (l) ruk (r) cag (c) goy (g) pum (p) fet (f)	1		-			-	-
14	y h l r c g p f		1	-			-	-
15	y h l r c g p f			-			-	-
16	y h l r c g p f	f		-			-	-
17	y h l r c g p f	y	y	1	y	y	1	1
18	y h l r c g p f	(S withdrawn from experiment)						

APPENDIX VIIId

Raw Data Relating to the No. of 3 Consecutively Errorless Association Responses by OPL Females to any ONE Stimulus Pair During Testing

S	Stimuli	Immediate Retention Testing			Delayed Retention Testing			Total No. of 12 Correct Responses
		Test Cards	Test Bk	No. of 6 Correct Responses	Test Cards	Test Bk	No. of 6 Correct Responses	
19	yad (y) hov (h) lep (l) ruk (r) cag (c) goy (g) pum (p) fet (f)	r	r	1	r	h r	1	1
20	y h l r c g p f		r	-			-	-
21	y h l r c g p f	y h	y f	1	y f	y	1	1
22	y h l r c g p f		f	-	f	f	1	-
23	y h l r c g p f	f	f	1	p		-	-
24	y h l r c g p f	r		-	l r p	y	-	-

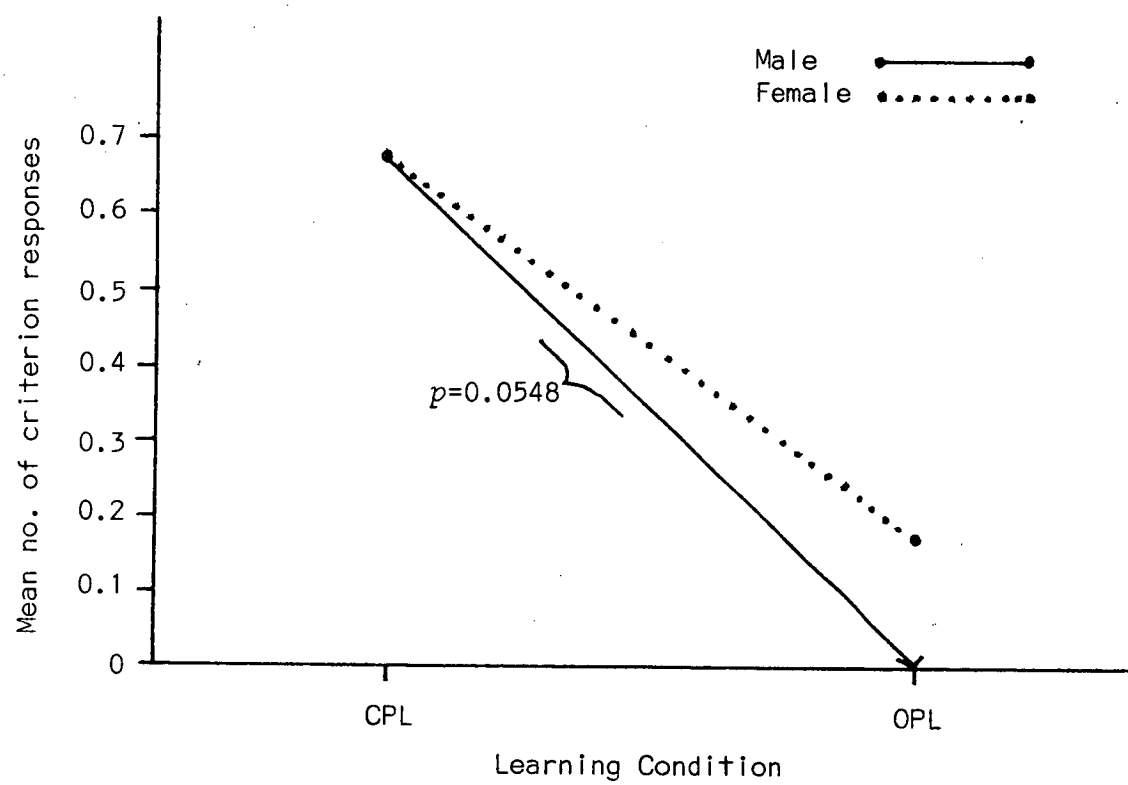
APPENDIX IX

2 x 2 Analysis of Variance for Sex and Learning Condition
(learning evident only in delayed retention testing)

	SS	df	MS	F	P
S	0.0396	1	0.0396	0.1371	0.7152
LC	1.9444	1	1.9444	6.7172	0.0178 *
S x LC	0.0396	1	0.0396	0.1371	0.7152
Error	5.5000	19	0.2894		
Total	7.4782	22	0.3399		

APPENDIX X

Mean No. of Criterion Responses During Delayed Retention Testing
Which Did NOT Occur During Immediate Retention Testing



APPENDIX XI

Raw Data: No. of Errors Occurring During the 5 Trials of the Learning Phases in Sessions 1 and 3

S	Session One					Total Errors Session One	Session Three					Total Errors Session Three	Grand Error Total
	1	2	3	4	5		1	2	3	4	5		
CPL males													
1	2	2	3	2	1	10	2	-	3	4	1	10	20
2	4	2	1	2	-	9	2	-	-	1	-	3	12
3	2	2	2	3	-	9	-	-	-	-	-	0	9
4	7	4	2	2	2	17	3	2	2	2	1	10	27
5	3	1	3	4	2	13	2	2	2	-	3	9	22
6	3	2	2	-	-	7	5	2	4	1	-	12	19
CPL females													
7	2	4	3	3	1	13	3	3	2	1	1	10	23
8	4	5	7	4	3	23	4	3	2	2	3	14	37
9	4	4	1	1	3	13	8	6	3	2	1	20	33
10	4	-	10	4	2	20	4	2	2	3	-	11	31
11	2	-	3	2	1	8	-	1	-	-	2	3	11
12	6	3	3	1	4	17	3	3	3	2	3	14	31
OPL males													
13	2	-	2	1	-	5	3	2	2	2	2	11	16
14	1	-	-	-	-	1	-	-	-	-	-	0	1
15	-	-	-	-	-	0	-	-	-	-	-	0	0
16	-	-	-	-	-	0	1	-	-	-	-	1	1
17	-	-	-	-	-	0	-	-	-	-	-	0	0
18	(withdrew from experiment)												
OPL females													
19	-	-	-	-	-	0	-	-	-	1	-	1	1
20	-	-	-	-	1	1	-	1	-	-	-	1	2
21	1	-	-	-	1	2	-	-	1	-	-	1	3
22	1	-	-	-	-	1	-	-	-	-	-	0	1
23	1	1	-	-	1	3	1	-	-	-	2	3	6
24	-	1	-	-	1	2	1	-	-	-	-	1	3

APPENDIX XII

Raw Data: Time (in seconds) Taken to Complete Each of the 5 Trials of the Learning Phases in Sessions 1 and 3

S	Session One					Session Three				
	1	2	3	4	5	1	2	3	4	5
CPL males										
1	21	10	16	11	11	17	10	16	16	14
2	38	24	15	23	11	15	14	14	14	17
3	27	19	18	19	7	15	13	19	16	17
4	36	18	14	16	11	16	10	9	13	13
5	35	16	21	24	17	11	13	11	10	12
6	23	26	18	15	12	40	28	28	25	13
CPL females										
7	22	22	17	13	12	17	13	12	10	14
8	27	26	22	14	19	19	16	13	13	17
9	64	48	20	18	23	46	29	18	16	14
10	57	16	57	38	23	28	22	17	17	12
11	57	21	25	25	19	20	31	16	17	23
12	51	23	17	14	19	16	16	16	13	19
OPL males										
13	10	5	9	8	5	8	6	8	8	8
14	15	15	11	7	7	11	10	7	8	9
15	23	18	16	13	12	14	18	13	12	15
16	11	15	11	10	10	12	10	10	11	9
17	13	14	14	10	12	14	10	14	14	17
18	(withdrew from experiment)									
OPL females										
19	15	9	13	8	7	13	8	9	9	9
20	18	16	12	15	10	13	16	12	11	12
21	11	9	8	6	8	8	9	10	7	8
22	34	20	13	13	10	24	12	14	8	11
23	28	20	15	15	13	17	15	14	12	12
24	20	19	15	11	14	12	12	8	8	10